



# The Journal of Bone and Joint Surgery

The Official Publication of the  
AMERICAN ORTHOPAEDIC ASSOCIATION  
and the BRITISH ORTHOPAEDIC ASSOCIATION

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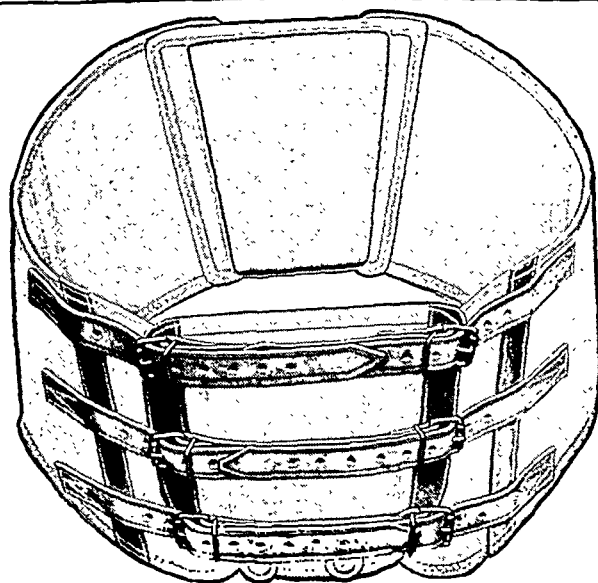
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# The Journal of Bone and Joint Surgery

## OPERATIVE ARRESTMENT OF LONGITUDINAL GROWTH OF BONES IN THE TREATMENT OF DEFORMITIES \*

BY D. B. PHEMISTER, M.D., CHICAGO, ILLINOIS

*Department of Surgery of the University of Chicago*

Inequality in length of the extremities during the growing period may result from a variety of causes. Among these are:

1. Fractures with overriding of fragments or obliteration of an epiphyseal line.

2. Joint infections with destruction of an adjacent epiphysis. This results in shortening and is seen especially in the upper end of the femur as a result of tuberculous or pyogenic infection of the hip. Tuberculous arthritis of the knee may produce excessive longitudinal growth, but rarely of an amount that results in a noticeable deformity.

3. Bone infections. They may result in shortening either from partial or complete obliteration of an epiphyseal line or from destruction of a segment of the shaft of a bone. Occasionally lengthening from excessive regional overgrowth of bones is due to extensive pyogenic osteomyelitis. Thus, in case of osteomyelitis of the femur the involved extremity may be as much as one or two inches longer than the normal one due to overgrowth, not only of the femur but also of the tibia and fibula. Speed<sup>1</sup> has reported such cases. Osteomyelitis variolosa may produce shortening of one to several bones from obliteration of epiphyseal lines as reported by Brown and Brown.<sup>2</sup>

4. Bone tumors arising in connection with the ends of the shafts of growing long bones. These are nearly always either enchondromata or exostoses. Enchondroma may be single or multiple. The condition of multiple enchondroma affecting a number of bones in one or more extremities which was designated by Ollier as dyschondroplasia nearly always results in shortening and often in curvature or angulation of the involved limb. Single enchondroma resulting in shortening is most frequently seen in the lower end of the ulna. Multiple cartilaginous exostoses result in less marked shortening than multiple chondroma, but there is almost

\* Presented at the Annual Meeting of the American Orthopaedic Association, Toronto, June 18, 1932.

constantly some shortening of both ulna and fibula and it may be of marked degree in the ulna. The short ulna results in ulnar deviation of the hand and bowing of the radius, and sometimes dislocation of its head. The short fibula results in lateral subluxation of the astragalus and eversion of the ankle. Single exostosis rarely results in shortening. Arrestment or retardation of longitudinal growth is rarely produced by other types of tumors or by solitary bone cyst. Regional fibrocystic disease may make shortening, but more from fracture with bowing than from retardation of growth.

5. Congenital disturbances may result in either shortening or lengthening of the bones of the extremity. Local or regional giant growth and von Recklinghausen's neurofibromatosis are occasional causes of abnormal lengthening of bones of the extremities. Congenital absence of one or both epiphyses or occasionally of an entire bone may be the cause of marked shortening in either the upper or lower extremity. Arteriovenous aneurysms in children, which are nearly always congenital, usually result in lengthening of the affected limb as illustrated by the report of twenty-three cases by Horton<sup>3</sup>, with lengthening in eighteen.

6. Infantile paralysis affecting markedly one lower extremity with the other either normal or only slightly involved usually retards growth so that there is considerable difference in the length of the limbs.

Arrest or retardation of longitudinal growth on one side only of the epiphyseal line results not only in shortening but also in angulation, due to continued although lessened growth on the other side.

It is a long established fact that all longitudinal growth of the shafts of bones of the extremities takes place through the cartilaginous epiphyseal lines. The recent experiments of Gatewood and Mullen<sup>4</sup> proved that this is so, even when the epiphyseal lines are fused during the growing period. They found that there was no compensatory lengthening of the growing shaft of the femur, whose lower epiphysis was fused with the shaft at a comparatively early age.

The extent of inequality of length varies greatly with the cause and the length of time that the causative agent was active. Thus shortening of the shaft produced by healing of an overriding fracture may be marked at first, but gradually become less and finally disappear as a result of compensatory overgrowth through its epiphyseal lines. This is well illustrated by the observations of David<sup>5</sup> in case of fractures of the shaft of the femur in young children. In a study of seventy-five cases he observed shortening at the end of six to eight weeks, ranging from one-half to two inches in thirty-eight cases. Subsequent study of these cases showed a return to normal length in practically every case in from two to nineteen months depending upon the amount of shortening. An abnormally long bone produced by osteomyelitis in one leg might possibly be expected to set up compensatory overgrowth of the bones of the other leg. Bergmann<sup>6</sup> observed equalization of length years after overgrowth produced by tuberculosis of the knee beginning in early childhood. Compensatory retardation of growth in the normal limb as an equalizing factor

is a possibility but has not been demonstrated. Osborne and Mendel<sup>7</sup> and Winters, Smith, and Mendel<sup>8</sup> have shown that rats have a growth potentiality which may be temporarily slowed down by restriction of certain foods or inorganic salts, but after removal of the restraining influence the loss is quickly made up. However, the skeleton continues to grow during the period of retarded growth and is only slightly smaller than in the controls.

#### OPERATIVE TREATMENT

In case of disease, tumor, or injury resulting in shortening of bones, the ultimate difference in length of the extremities is often sufficient to result in varying degrees of limp or noticeable deformity. Operative measures designed to equalize the length of limbs have been but little used. They consist of bone lengthening of the shorter limb or bone shortening of the longer limb.

Bone lengthening has been made more practical in recent years by the operation of Leroy Abbott<sup>9, 10</sup>. None of the measures that were previously used gave results that compared favorably with it. While Abbott's operation in the hands of experts has yielded a fairly high percentage of successful results it is a complicated procedure for the average general surgeon and one that should not be lightly attempted by the uninitiated.

Harris<sup>11</sup> has performed lumbar sympathectomy for the purpose of stimulating longitudinal growth in case of shortening of the lower limb due to infantile paralysis. A limb with retarded longitudinal growth during the paralytic stage might undergo compensatory lengthening after increased function from improvement or disappearance of the paralysis. Bisgard<sup>12</sup> performed unilateral lumbar sympathectomy on young goats and found no difference in length of the posterior extremities at the time of closure of the epiphyseal lines.

Shortening of a bone of the longer limb by resection of a portion of its shaft has been used to a very limited extent in the lower extremity for the correction of slight or moderate limp, but operation has oftenest been performed on adults. Camera<sup>13</sup> has used it twenty-one times in children with good results.

Arrestment of growth at the end of a bone by operative fusion of the epiphysis with the shaft is a procedure, which, if performed at the proper age and location, may serve to so retard growth in the longer extremity as to equalize the length of the two limbs by the time adult life is reached. It may be indicated in the lower extremity for doing away with limp. Excision of an epiphysis or unilateral epiphyseodiaphyseal fusion, with complete arrest of longitudinal growth on one side only, may be indicated in either the forearm or the leg for doing away with curvature or angular deformity, the result of shortening of one of the two bones of the part.

In the following case of dyschondroplasia in a child with shortening and curvature of the left upper and lower extremities, the upper epiphysis of the left radius was excised for correction of deformity of the forearm and the lower epiphysis of the normal right femur was fused with the shaft to arrest longitudinal growth in an attempt at equalization of length of the



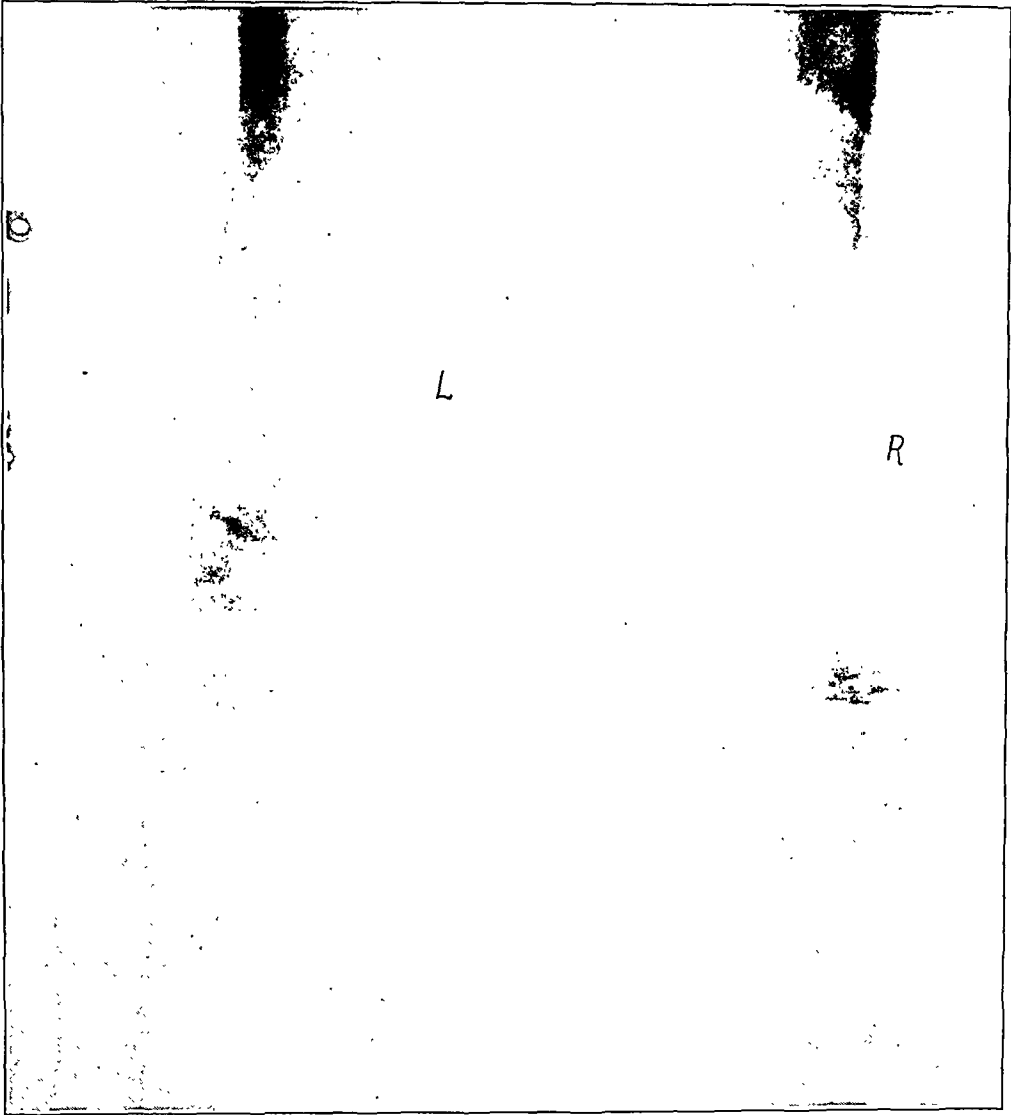


FIG. 1

CASE 1. Shortening and chondroma of left femur and fibula; genu valgum of left knee.

lower limbs. Ten years have elapsed since the epiphyseodiaphyseal fusion of the femur and six years since the upper radial epiphysis was excised and full growth of the bones has been attained in the nineteenth year, so that the end results of the operations are known.

CASE 1. Female, present age eighteen years and four months, was first seen at the age of seven years and nine months. The left upper and lower extremities had been shorter than the right since birth. There had been nodules on the bones of the fingers that were slowly increasing in size and there was left genu valgum. There was no history of a similar disturbance in any member of the family. Physical examination at that time revealed a female, fifty-one inches tall, who appeared normal aside from the left upper and lower extremities. The left arm was two inches shorter than the right, the shortening being mainly in the forearm and hand. The radius was slightly curved outward. There were numerous nodules in the course of the finger bones. The left lower extremity measured twenty-four and one-quarter inches from the anterior superior spine to the internal malleolus, while the right measured twenty-seven inches. There was a moderate

left knock-knee. The shortening was mainly in the femur, the left knee being almost two inches higher than the right (Fig. 1). There was slight enlargement of the outwardly curved lower end of the left femur and of the upper end of the left fibula and lower end of the left tibia. Roentgenograms revealed broad streaks of reduced density in the upper end of the left humerus and wing of the left ilium, the upper and lower ends of the shaft of the left femur, the lower end of the left tibia, and the upper end of the left fibula. There were punched-out areas of reduced density in the left finger bones. The left ulna was one and one-half inches shorter than the radius and the shaft of the radius was curved outward (Fig. 2). A diagnosis was made of multiple enchondroma, or Ollier's dyschondroplasia. At the age of eight years and seven months the measurements were as follows: anterior superior spine to internal malleolus,—right, twenty-eight inches, left, twenty-five and one-half inches; top of greater trochanter to lower border of external condyle of femur,—right, fourteen inches, left, twelve inches; tibia,—right, eleven and one-half inches, left, eleven inches. At that time the lower epiphysis of the right femur was fused with the end of the shaft by making incisions mesially and laterally, followed by excision of the cartilaginous disc to a depth of approximately one centimeter along its exposed sides by means of an osteotome and by sliding a bone graft about one by two and one-half centimeters from the lower cortex of the shaft downward into a groove cut into the side of the bony epiphysis so that it bridged the epiphyseal line on either side (Fig. 3). It was estimated that about two inches of longitudinal growth of the femur would be prevented. Subsequent roentgenograms (Fig. 4) showed bony fusion of epiphysis and metaphysis with complete arrestment of longitudinal growth. Figure 5 shows the shortening and deformity that were still

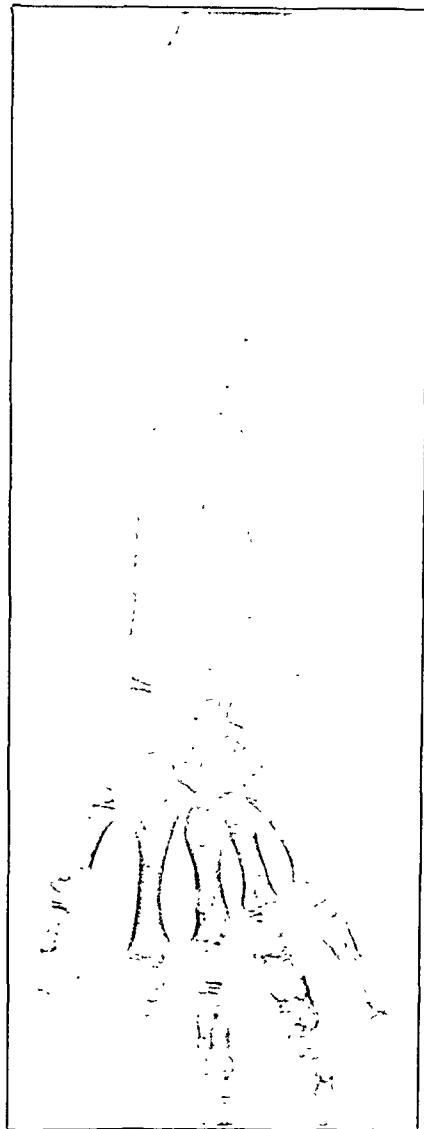


FIG. 2

CASE 1. Multiple chondroma of hand, chondroma of lower end of shortened ulna, curvature of radius, and ulnar deviation of hand.

present at the age of nine years and eight months. At the age of ten years and four months an osteotomy was performed three inches above the epiphysis of the lower end of the left femur; the hyaline cartilage filling the lateral aspect of the bone was curetted out and the genu valgum corrected. Several of the nodules on the finger bones of the left hand were removed with the curet and found to consist of hyaline cartilage.

As time went on the disproportion between left radius and ulna increased; the radius became more curved and its head became partly dislocated outward and upward. At the age of twelve years and four months the head (including epiphyseal line) of the left radius was excised with the intention of securing greater equalization of radius

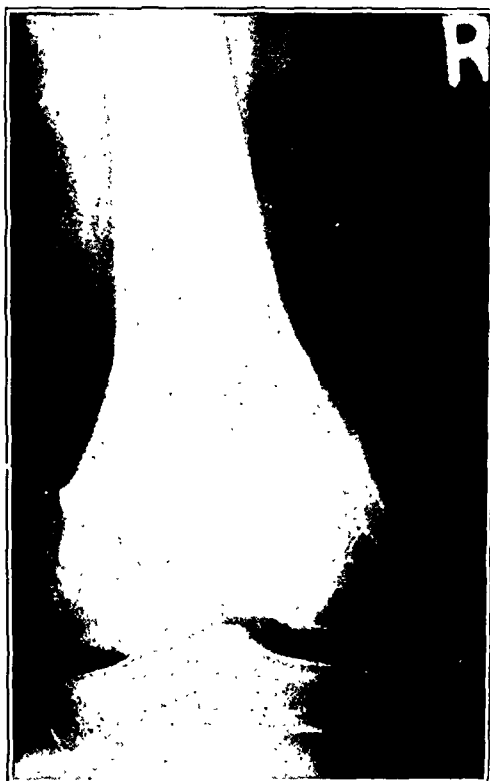


FIG. 3

CASE 1. Right knee, thirty-eight days after operation of epiphyseodiaphyseal fusion of lower end of right femur.



FIG. 4

CASE 1. Forty-three months after epiphyseodiaphyseal fusion of lower end of right femur.

and ulna during the remaining period of growth. Improvement was anticipated more from the excision than from the arrest of growth, since little further increase in length of radius would have resulted at the upper end.

The patient was seen recently, at the age of eighteen and one-third years, or nine and three-quarters years after the arrestment of growth in the lower end of the right femur. The limp in the left leg gradually diminished up to the age of sixteen, since which time it has been slight and has remained stationary. She wears a three-quarters-inch elevation of the left heel which completely does away with it. After excision of the head and neck of the left radius, the curvature of the forearm and angulation of the hand slowly improved. Figure 6 shows the roentgenographic appearance. The patient is five feet, five inches tall. Examination reveals four inches of shortening in the left upper extremity, three of which are in the forearm and hand. The extremity is freely used, but is a trifle weaker than the right. The forearm is slightly curved and the hand slightly smaller than normal. The cartilaginous nodules on the fingers, all of which were excised, except two small ones, have not recurred.



FIG. 5

CASE 1. Shows shortening and genu valgum thirteen months after fusion, age nine years and eight months. Left shoe elevated.

The lower extremities are straight and function normally aside from the slight limp. There is slight enlargement of the left tibia above the ankle, and the foot is one-half of an inch shorter than the right. The left patella is slightly subluxated laterally as a result of the old genu valgum which is now corrected. Measurements from the anterior superior spine to the internal malleolus are as follows: right, eighty-one and one-half centimeters; left, seventy-

nine centimeters. In order to determine more accurately the relative lengths of the bones, a single film teleroentgenogram of the lower extremities was taken with the patient standing at a target distance of nine feet and two inches (Fig. 7). On it the measurements were as follows: right femur, sixteen and one-half inches (41.8 centimeters); left femur, sixteen and one-quarter inches (41 centimeters); right tibia, fifteen inches (38 centimeters), left tibia, fourteen and one-quarter inches (36 centimeters). The roentgenogram shows the lower end of the right femur practically normal in appearance. The upper and lower ends of the left femur, tibia, and fibula show slight expansion and irregular thinning of cortex of ends of the shafts, but shadows of cancellous bone are present, indicating that the cartilaginous areas have been replaced by bone. All epiphyseal lines are closed. Figure 8 shows a roentgenogram of the knees with the legs straight;

Figure 9, a photograph at the age of seventeen.

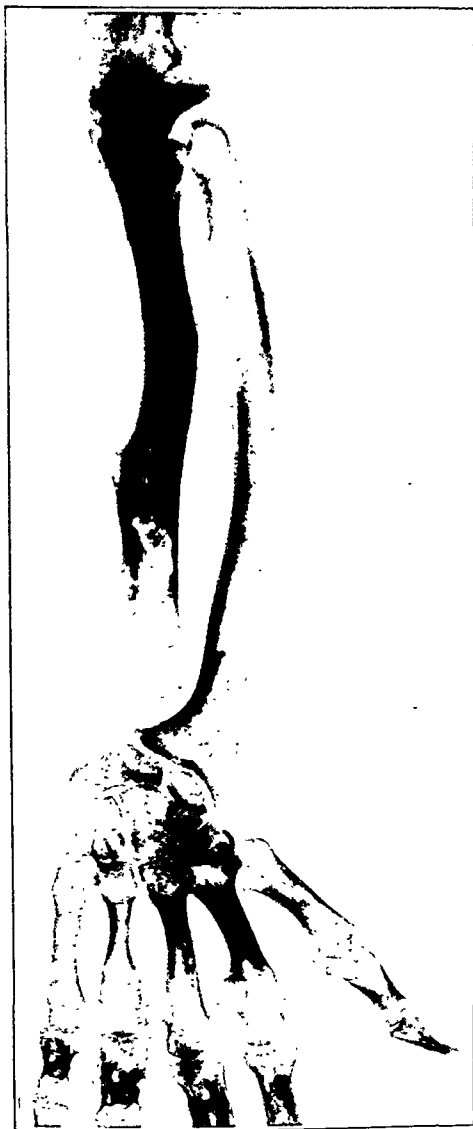


FIG. 6

CASE 1. Condition at age of eighteen years and four months.

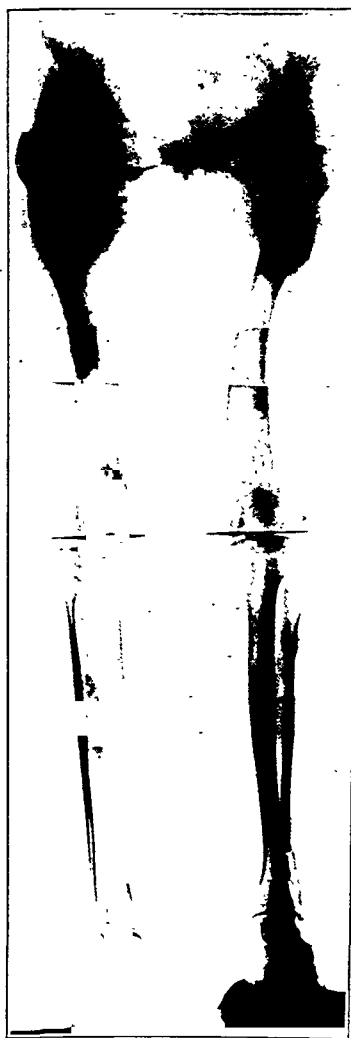


FIG. 7

CASE 1. Teleroentgenogram of lower extremities at age of eighteen and one-third years.



FIG. 8

CASE 1. Knees taken on same film, showing fusion of all epiphyseal lines and healing of chondromata. Left patella subluxated.

The result of the arrestment of longitudinal growth at the lower end of the right femur has been to produce a femur approximately two inches shorter than it would have been and only one-quarter of an inch longer than the diseased left one. This, along with the osteotomy of the left femur, has rescued the patient from a very marked limp and deformity. The slight limp with which she is left, and which will be permanent, is due mainly to the three-fourths inch of shortening in the left tibia and fibula. A better result could have been obtained had the epiphyseodiaphyseal fusion of the lower end of the femur been performed at an earlier date or, preferably, had the same procedure been carried out subsequently on the upper end of the right tibia and fibula at the date—ten to eleven years of age—which would have resulted in one inch of shortening now when longitudinal growth is complete.



FIG. 9  
CASE 1. Appearance at age of seventeen.

Because of the success obtained in this case longitudinal growth arrest has been regarded as a justifiable procedure in properly selected cases. Consequently during the past four and one-half years in the University of Chicago Clinics, twenty patients\* have been subjected to epiphyseodiaphyseal fusions on the longer side for the purpose of equalizing length of lower limbs, two patients to epiphysectomy, once on the ulna and once on

\* Fourteen additional cases operated on at time of proof correction, December 1932.

the fibula, for equalization of length of the two bones in the segment, and one patient to unilateral epiphyseodiaphyseal fusions for the correction of angular deformity at the wrist and ankle due to short ulna and fibula. All except one of the twenty patients with one lower limb shorter than the other have been operated on by Dr. Compere, Dr. Hatcher, or Dr. Keyes during the past nine months. Epiphyseodiaphyseal fusion was obtained in every case, but the time is too short for judging the equalizing influence on length of limbs. The causes of the shortening were: tuberculosis of the hip, eight cases; arrested longitudinal growth from osteomyelitis, two cases; congenital dislocation of the hip, two cases; poliomyelitis, three cases; tuberculosis of the knee, one case; dyschondroplasia, two cases; congenital pseudarthrosis with shortening of tibia, one case; and retarded growth with congenital club-foot, one case. The difference in length of limbs ranged from three and five-tenths to eleven centimeters and the ages from seven to fifteen years. The operation consisted of fusion of the lower epiphysis of the femur in nine cases, and lower epiphysis of femur and upper epiphysis of tibia and fibula in ten cases. The operative technique for fusions about the knee is illustrated by Figure 12.

Incisions six centimeters long are made mesially and laterally exposing the sides of the epiphyseal lines of the femur. A mesial incision exposes the mesial side of the epiphyseal lines of the tibia, and a lateral one the lateral side and also the anterior side of the line of the fibula. A piece of cortex, three centimeters long by one to one and a half centimeters wide, is excised, crossing the cartilaginous line and including about one centimeter of the epiphysis. The sides of the cartilaginous disc anterior and posterior to this are chiseled out to a depth of approximately one centimeter and the transplant reinserted with its ends reversed. In case of the fibula the epiphysis is separated with a chisel, the cartilaginous disc excised, and a metaphyseal graft shifted upward. In some instances the epiphysis of the fibula, including the cartilaginous disc, has been excised.

CASE 2. One patient, a boy with dyschondroplasia affecting the ends of both femora and the left tibia, had marked curvature of both lower limbs, moderate shortening of the right limb, and extensive shortening of the left. Four and a half years ago, at the age of nine, he had osteotomy of both femora and the left tibia for correction of deformities and epiphyseodiaphyseal fusion of the lower end of the right femur for equalization of limb length. Two years and seven months ago the difference in length of the limbs still amounted to three and one-half inches and moderate genu valgum right and genu varum left had recurred. Bilateral femoral osteotomy was again performed for correction of the angular deformities and one inch of overriding of fragments was allowed on right femur for the production of shortening. Epiphyseodiaphyseal fusion was performed on the upper ends of the right tibia and fibula. Since then the limbs have remained straight and have gradually approached each other in length until now, at the age of thirteen and one-half years, the left leg is only two inches shorter than the right. Arrest of growth at the lower ends of the right tibia and fibula may become necessary at a later date if equalization does not progress rapidly enough.

In the following case arrest of growth and bone excision were performed for the correction of deformity at the wrist.

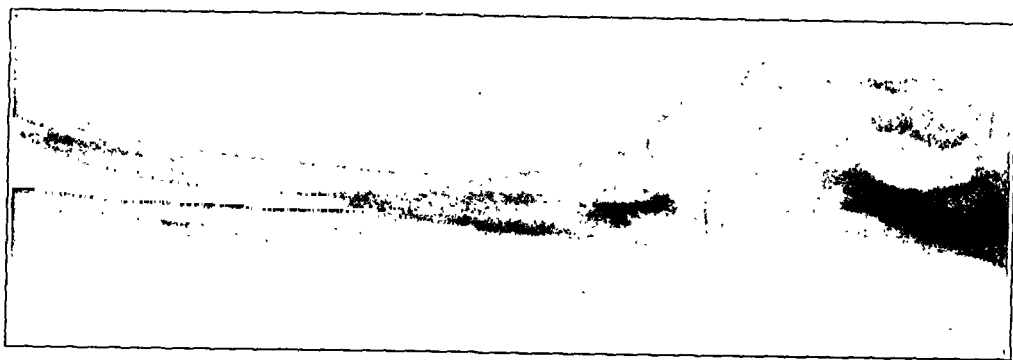


FIG. 10

CASE 2. Shortening of radius and obliquity of its lower epiphysis at age of twelve, resulting from fusion of epiphysis and shaft anteriorly at age of four.

CASE 3. Epiphyseal excision was practised in the case of a girl who had marked shortening of the radius with extreme prominence of the lower end of the ulna and radial angulation of the hand. This was the result of injury to the anterior portion of the epiphyseal line from excision of a cartilaginous exostosis of the lower end of the shaft of the radius at the age of four. A bony bridge formed anteriorly, but longitudinal growth continued posteriorly. Figure 10 shows the anterior angulation of the lower radial epiphysis and the backward and downward projection of the ulna beyond the wrist joint at the age of twelve. Osteotomy of the radius was then performed and the angulation of the lower fragment was corrected. At the age of thirteen the lower epiphysis, including the cartilaginous disc, was excised, thereby shortening the ulna and preventing further longitudinal growth. At the age of sixteen (Fig. 11) the ulna extends but slightly beyond the line of the wrist joint and the deformity is considerably improved. Practically the maximum improvement has been reached since very little future growth will take place from the upper end of the radius.

In the following case unilateral arrest of growth was practised for correction of angulation at the wrist and ankles.

CASE 4. A boy, aged twelve years, had multiple cartilaginous exostoses with shortening of both ulnae and both fibulae. On the right side the ulna was one and three-quarters inches shorter than the radius, as a result of which there was curvature of the radial shaft and ulnar inclination of the lower radial epiphysis and wrist. The shortening in the fibula had resulted in outward displacement of the astragalus on either side beneath the external malleolus and external obliquity of the lower tibial epiphysis, more marked on the left side. At the age of twelve epiphyseodiaphyseal fusion was carried out on the lateral side of the lower end of the radius. This resulted in arrested longitudinal growth of the radius laterally, but it continued on the ulnar side and one month ago, or two years and two months later, the epiphyseal line had lost its obliquity, thereby lessening

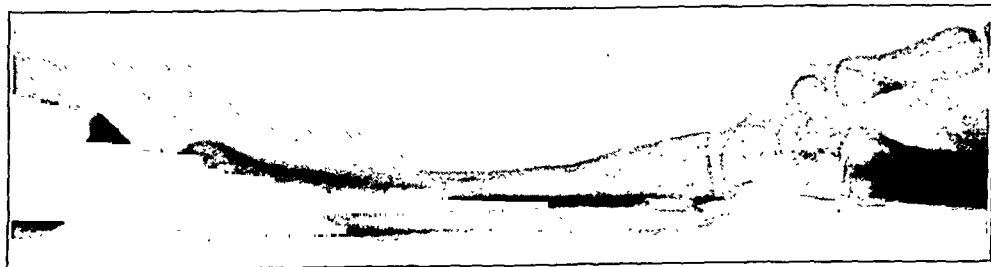


FIG. 11

CASE 2. Condition at age of sixteen, three years following excision of lower epiphysis of ulna and four years after osteotomy and correction of obliquity of radial epiphysis.

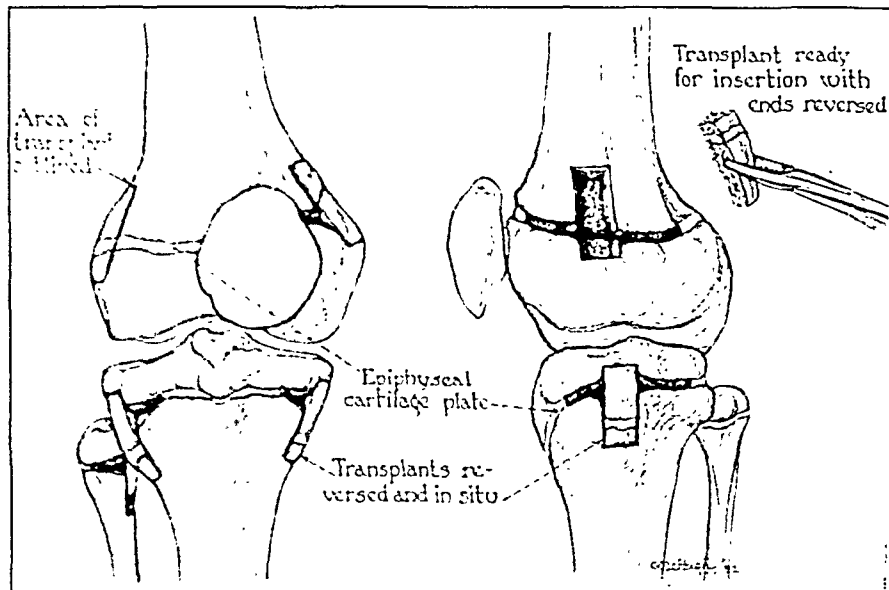


FIG. 12

Sketch of technique of epiphyseodiaphyseal fusion. Transplants reversed and cartilage chiseled out.

considerably the ulnar angulation of the hand. The ulnar longitudinal growth had been but slight. At that age unilateral epiphyseodiaphyseal fusion was carried out on the mesial side of the lower end of either tibia in the hope that subsequent downward growth of the lateral portion of the tibia and of the fibula will correct the eversion of the ankles by the time adult life is reached.

#### DISCUSSION

When equalization of length of limbs is attempted by epiphyseodiaphyseal fusion the greatest care should be exercised in the choice of time, and location and number of epiphyses to be fused. In some instances the lower epiphysis of the femur should be fused, in others the upper epiphyses of tibia and fibula, while in still others both the lower femoral and the upper tibial and fibular epiphyses should be fused, either at the same time or at different times according to the amount of shortening to be accomplished.

Measurements should be made of body length, length of limbs, and total, and diaphyseal lengths of the bones to be compared. These are made in the usual way, but length of the long bones and of their diaphyses are best made from teleroentgenograms of the entire lower extremities. Table I gives the measurements of normal femora and tibiae in six individuals during the growing period from teleroentgenograms taken at a target distance of nine feet, two inches (280 centimeters) which are sufficiently near the actual lengths to be used for comparison. Table II gives measurements for different ages obtained by Toldt<sup>15</sup> from skeletons.

The differences in lengths of the homologous limbs, bones, and diaphyses are thus obtained.



TABLE I  
LENGTHS MEASURED FROM TELEROENTGENOGRAMS

Sex and Age	Femur		Tibia	
	Entire bone	Diaphysis	Entire bone	Diaphysis
Female 8 yrs.	37 cm. 14½ in.	33 cm. 13 in.	31 cm. 12½ in.	28.3 cm. 11⅛ in.
Male 12 yrs.	40 cm. 16 in.	36.8 cm. 14¼ in.	31.7 cm. 12½ in.	29 cm. 11⅜ in.
Female 13 yrs.	42.8 cm. 16⅞ in.	39.5 cm. 14⅜ in.	36.5 cm. 14⅜ in.	33½ cm. 13¼ in.
Female 13 yrs.	44.5 cm. 17½ in.	39.7 cm. 15⅝ in.	35.5 cm. 13⅞ in.	32.6 cm. 12⅞ in.
Male 14 yrs.	44.5 cm. 17½ in.	39.6 cm. 15⅝ in.	35 cm. 13¼ in.	32.4 cm. 12¾ in.
Male 16 yrs.	48 cm. 19⅛ in.	43.2 cm. 17 in.	39 cm. 15½ in.	36.5 cm. 14⅜ in.

The next problem is to try to estimate the amount of longitudinal growth that will henceforth take place in the respective limbs, bones, and diaphyses and also the amount from either end of each diaphysis concerned. From these data the inequality in length of limbs that will obtain in adult life may be estimated. There may be a good deal of inaccuracy in such estimations because of a number of factors. As previously stated, the rate of growth in the shortened limb may vary according to whether or not the cause of the shortening remains active. The same is true for a limb lengthened as a result of disease such as osteomyelitis. Allowance should be made for this fact in making estimations. Another factor is that the amount of longitudinal growth which takes place from each end of the diaphysis of the various extremity bones has not yet been determined with great accuracy. Different methods have been employed. Stephen Hales<sup>16</sup> in 1747 pierced two holes in the cortex of the tibia of a growing chicken and two months later found the distance between them to be the same, but the bone had increased in length one inch, most of which had occurred at the upper end. Thus he demonstrated the absence of interstitial growth in the shaft and the presence of unequal longitudinal growth at the ends of the shaft.

Similar and somewhat more accurate observations were made by Duhamel who implanted silver stylets and by John Hunter who implanted shot in the shafts. It had long been known that the epiphysis fuses with the shaft earlier at one end than at the other and the view prevailed that because of this there is more increase in length from the end at which fusion occurs last.

Broca in 1852 observed that the cartilage disc between bony epiphysis and diaphysis is thicker at one end than at the other, that the canal

for the nutrient artery is farther away from the thicker cartilage disc and becomes proportionately more so with increasing age. From this he deducted that there is more longitudinal growth at the end of the shaft with the thicker cartilage disc.

Humphrey<sup>15</sup> in 1861 reported experiments in which he fed madder to hogs and noted greater longitudinal growth from one end than from the other after the madder was stopped. He also noted that the nutrient canal slopes away from the end of the bone at which the epiphysis closes last and that there is more rapid and prolonged growth at this end.

Ollier<sup>17</sup> implanted shot in the middle of the shaft of bones of young rabbits and determined the amounts of growth from the two ends after varying intervals. He found for the fore limb the least growth from the end nearest the elbow and for the hind limb the most growth from the end at the knee. He reported one-fifth of the longitudinal growth of the arm and forearm bones from the ends at the elbow and almost two-thirds of that of the thigh and leg bones from the ends at the knee which for the forearm and leg bones is very inaccurate. Ollier also observed clinically that resection of the knee early in life, as for tuberculosis in which the epiphyses were removed, resulted in marked limb shortening, whereas similar resection of the elbow resulted in little shortening.

Perhaps the most accurate method reported for estimating the amount of longitudinal growth that takes place at the ends of the various bones is that employed by Digby. He prolonged the axis of the nutrient foramen to the center of the medullary canal of the shaft and reckoned that as the point of primary ossification. The distance from this point to each end of the shaft represents the amount of diaphyseal growth from that end. The results in one adult skeleton were as follows:

TABLE II  
TOLDT'S TABLE OF TOTAL AND DIAPHYSEAL LENGTHS OF FEMUR AND TIBIA

<i>Sex and Age</i>	<i>Femur</i>		<i>Tibia</i>	
	<i>Entire bone</i>	<i>Diaphysis</i>	<i>Entire bone</i>	<i>Diaphysis</i>
Female 4 yrs.	21.3 cm.	18.2 cm.	17.8 cm.	15.3 cm.
Male 6½ yrs.	25.6	22.2	20.3	17.6
Male 12 yrs.	38.3	34.5	30.8	28
Male 15 yrs.	42.2	38.3	35.3	32.1
Male adult— average of 9	46.7		37.4	
Female adult	41.1		33.5	

Femur—upper end, 5 inches; lower end, 11 inches.

Tibia—upper end,  $7\frac{1}{2}$  inches; lower end, 5 inches.

Fibula—upper end,  $7\frac{1}{2}$  inches; lower end, 5 inches.

Humerus—upper end,  $9\frac{1}{2}$  inches; lower end,  $2\frac{1}{2}$  inches.

Radius—upper end, 2 inches; lower end, 6 inches.

Ulna—upper end,  $1\frac{3}{4}$  inches; lower end,  $5\frac{5}{8}$  inches.

No similar measurements have been reported for growing skeletons.

I measured in this way the diaphyses of humerus, femur, and tibia of a sixteen-year-old male skeleton with the following results:

Left humerus—upper end, 21.8 centimeters; lower end, 7 centimeters.

Left femur—upper end, 13 centimeters; lower end,  $28\frac{1}{2}$  centimeters.

Left tibia—upper end, 19.5 centimeters; lower end, 15.8 centimeters.

These measurements correspond well with those of Digby.

Stevenson<sup>14</sup> gives the dates of fusion of the epiphyses with the shaft of the various bones as follows: humerus—upper end, twenty years, lower end, fifteen years; radius—upper end, eighteen years, lower end, nineteen years; ulna—upper end, seventeen years, lower end, nineteen years; femur—upper end, eighteen years, lower end, nineteen years; tibia—upper end, seventeen years to nineteen years, lower end, eighteen to nineteen years; fibula—upper end, seventeen to nineteen years, lower end, eighteen to nineteen years.

Roentgenographic studies of the diaphyses of bones that contain transverse striations as a result of interference with growth during illness, as scarlet fever, or as a result of phosphorus administration<sup>19</sup>, demonstrate well the difference in the rate and amount of growth at the two ends of the various bones, but no accurate measurements have been made in this way. They show growth rates somewhat similar to those of Digby's.

Payton<sup>21</sup> has recently studied the growth in length of bones of the madder-fed pig. He found that the rate of growth diminishes with age, the diminution being more rapid at the end of lesser increment and earliest cessation. The quantitative ratios of growth from the two ends were different from those calculated for man by the method of Digby<sup>20</sup>.

From the evidence at hand, it appears to be not entirely safe to draw conclusions as to the rates of growth at the two ends of a bone in man from those calculated for experimental animals.

More accurate studies of the total length of the growing shafts should be made for children of different ages by means of teleroentgenograms\*, and attempts should be made to determine the percentages of growth at the two ends by roentgenographic studies of patients with transverse striations in the metaphyses, such as result from scarlet fever.

In considering the indication for shortening in the lower limb, it is important to remember that the patient is more concerned about deformity than about height, and that one does not care greatly whether one is five feet, eight inches, or five feet, eleven inches tall, as long as there is no limp.

\* Since this was written, measurements have been made by Dr. Paul C. Hodges of our x-ray department by the stereotriangulation method. Working at a target distance of sixty inches with a tube shift of five inches and using eight by thirty-six inch films, the results have been very accurate.

## CONCLUSIONS

1. Selected cases of inequality of length of limbs during the growing period may be treated by epiphyseodiaphyseal fusion, arresting growth in the longer limb, and thereby approximating or equalizing limb lengths at the end of the growth period.

2. Angular deformities of the wrist or ankle, the result of disproportion in length of the two bones of the forearm or leg, may be improved by either unilateral or complete arrest of growth in the longer bone at the appropriate age.

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# EARLY TREATMENT OF CONGENITAL DISLOCATION OF THE HIP \* †

BY PROF. VITTORIO PUTTI, BOLOGNA, ITALY

I wish first of all to apologize to my colleagues of the British Orthopaedic Association because, after having been so highly honored as to be invited to this Congress, I have again chosen as my subject the same that I dealt with here on the occasion of the Joint Meeting of the American and British Orthopaedic Associations.

My reasons for this choice are primarily two:

1. Because I consider that the treatment of congenital dislocation of the hip is still a matter not merely of fundamental importance to orthopaedic surgeons, but also one on which the last word has not yet been spoken, and which, therefore, it is opportune to discuss afresh.

2. Because I considered it my duty to report to my colleagues of the British Orthopaedic Association the results which I have obtained up to date with the abduction method, since in 1929 I could only refer to a very limited number of cases.

I have already said that the treatment of congenital dislocation of the hip is still a subject open for discussion, and I sincerely believe that it should be discussed. More than forty years after the discovery of the method which its originator, Agostino Paci, called the rational and radical one, we cannot say that we have arrived at unanimity as to the methods to be adopted, nor in the estimation of results.

Thus, among English-speaking surgeons there are not a few who even now uphold the advisability of resorting much more often to reduction by open operation; while on the Continent of Europe the conviction is prevalent that closed reduction should be given the preference. Even more diverse are the opinions as to postoperative treatment. As to results, it is not to be disputed that not until the present time have we been in a position to give a balanced judgment on the actual value of the treatment. Indeed, not less than thirty years of experience were necessary to determine how a reduced joint would behave in advancing age,—in other words, what fate awaits it in the inevitable course of aging of the individual. And for those who can interpret it, for those who can command vast statistics, for those who are analyzing a well organized, well recorded material, this experience is highly instructive.

The German orthopaedic surgeons presented their experience at the Congress of Munich in 1929. Their analysis of results obtained in about thirty years on about 1500 cases, seen after a minimum period of three years from reduction, has led to rather comforting conclusions,—perfect and permanent results in nearly half the cases reexamined.

\* Read at the meeting of the British Orthopaedic Association, London, July 27, 1932.

† Translated by Dr. Maud F. Forrester-Brown.

I cannot foretell what conclusions the Italian orthopaedic surgeons will bring before the Congress which is to be held in Bologna next October; but, judging by the statistics of the Istituto Rizzoli alone, based on 3216 cases, of which about 600 were reexamined at a minimum period of five years after treatment, I think that the percentages will not be very different from those presented by the German surgeons.

This means that, contrary to what was assumed from the examination of cases recently treated, there is still a high percentage of dislocations in which the results of treatment are not completely satisfactory, or not satisfactory at all.

Many conclusions may be drawn from a study of the results of cases examined at periods of from five to thirty years later, but I shall limit myself to pointing out the principal ones:

1. It is a complete delusion that one can have a result permanently satisfactory in function in a hip incompletely reduced. This delusion has led to a too optimistic view of the results. Clinical and roentgenological observations of cases examined from five to thirty years after the end of treatment demonstrate irrefutably that every subluxated, or transposed hip, every hip in which one has not obtained from the first, or not preserved, normal anatomical relationship between the femoral epiphysis and the acetabulum, every such hip is inevitably destined to become the subject of that precocious articular senility, which is usually diagnosed as osteo-arthritis, or arthritis deformans. In other words, *no complete and permanent restoration of function occurs apart from perfect anatomical reduction.*

On the contrary, one cannot say that perfect anatomical reduction is synonymous with perfect function, because even the hip perfectly reduced may be subjected to reactive processes, which may compromise its function.

2. The primary causes of imperfect reduction or instability are anatomical in nature and are sufficiently well known to make it unnecessary for them to be dwelt upon. I consider that, rather than the bony abnormalities, it is those of the capsule and ligaments which are important. This conviction I acquired through the study of ten dissections of dislocations, the details of which I am about to publish.

3. The most uncertain element, on which the success of treatment depends, is the reactive processes to which the joint components are exposed, due either to the traumatism of the reduction or to prolonged immobilization. A very important factor in determining this reactive process is the constitutional one,—that is, the tendency of the individual to resent such mechanical stimuli as the joint encounters during reduction. The manifestations of joint reaction fall into two primary groups,—generalized osteo-arthritis, involving all the parts of the joint, and osteo-chondritis, which affects chiefly the femoral epiphysis.

4. The age of the patient is the most important factor in the result. This conclusion, on which we insisted in presenting our statistics to the Congress of Florence in 1913, is fully confirmed by an analysis of the cases

operated on in the last twenty years, even when one excludes those treated under the thirteenth month, of which I shall speak shortly.

It is well known how the structure of every joint, as well as its function, is completely dominated by the age of the individual. This axiom applies to the joint congenitally dislocated, but acquires special importance when it is considered in relation to the effects of the manoeuvres, which must be carried out in order to restore the joint to normal.

Statistics demonstrate irrefutably the effect of the age, at which treatment is started, on the results. Since we placed the maximum age for single dislocations at seven years, and for bilateral ones at four years, the percentage of successes has increased notably. But one is still too often induced to operate after these ages, and this mistake results in a lowering of the total percentage of successes.

I have referred to the age limits which up to now we consider the maximum. What is the minimum? If we consider the statistics of recent years in which the majority of patients have been operated on in what is generally considered the most favorable age,—that is, from the second to the third year—we see that the percentage of successes is undoubtedly improved; but it is still far below a satisfactory figure.

The causes of failure, apart from errors of technique, are, even at this age, the same that I have already indicated,—anatomical obstacles to primary, perfect reduction, resulting in appositions, transpositions, re-dislocations; and arthritic reactions, which cause contractures, stiffness, pain, and ankylosis. In other words, even in what is generally considered the ideal age for treatment, one encounters, though in lesser measure, the troubles which are so frequent in later life. Therefore one must reduce the age limit, *indeed abolish it completely*, and fully accept that principle, which all orthopaedic surgeons follow in the treatment of all congenital deformities, and which one sees no reason to repudiate in that of congenital dislocation of the hip,—that is, *to begin treatment the very moment the deformity is observed*, even if that be on *the day of birth*.

I explained in various publications and also to the Meeting in London in 1929 what the symptoms are which indicate a dislocation in the early days of life, so that it seems superfluous to repeat them. Increased experience has taught me to attach even more importance to the roentgenogram, and for that reason I gladly take the opportunity to insist again on a suggestion that I made long ago,—the necessity of submitting every new-born child to a routine x-ray examination of the hips. This suggestion appeared to some absurd, to others impracticable, and to still others not free from danger.

It can only appear absurd to those who do not consider the seriousness of a dislocation in regard to both individual and social life. That it is impossible to carry out will not seem likely, if we remember the widespread facilities for roentgenography already available and their certain increase in the future. As to the risks of exposing a new-born child to the action of x-rays, I do not think it exists, in view of the extreme rapidity of exposure made possible by modern apparatus.

TABLE I

## CASES OF CONGENITAL DISLOCATION TREATED BY ABDUCTION METHOD

Year	Number
1921-22.....	1
1923.....	1
1924.....	1
1925.....	1
1926.....	2
1927.....	6
1928.....	11
1929.....	28
1930.....	33
1931.....	35
Total.....	119

As shown in Table I the total number of cases is 119. It is not without interest to note the steady increase in the number of cases treated from 1922 to 1931. This progressive and suggestive increase is not accidental, but the result of increased experience in the recognition of dislocations, thanks chiefly to the greater use of roentgenological examinations and to the propaganda on a large scale among University students, practitioners, and more particularly among obstetricians, pediatricians, and mid-wives.

At first I hesitated to admit the existence of a state of *predislocation*, except when the clinical signs and x-ray findings agreed in making the diagnosis certain. Experience in a few cases, in which I have seen transformed, under my very eyes, a state of predislocation, evidenced merely by an increased tilting of the roof of the acetabulum and few clinical signs, into a complete dislocation, such an experience has taught me to rely completely on the roentgenological findings, which I now consider sufficient to prove a state of predislocation, even in the absence of any clinical signs whatever.

That propaganda designed to spread the knowledge of the existence of this condition of predislocation has borne good fruit is proved by various evidences. Indeed, not a small percentage of the patients treated by the abduction method were sent to us by pupils and colleagues.

The second table seems to us of some importance as it shows that, in a comparison between predislocations and frank dislocations, the percentages of the sexes and sites of dislocation do not differ much; wherefore, one may draw the conclusion that a predislocation is really a potential dislocation.

As to the age at which treatment was started,—the youngest case of predislocation was a baby thirty-four days old, and the oldest sixteen months. The average age (nineteen cases) was four months. Only four babies were more than one year old. The shortest term of treatment was four months, the longest twenty months. In the majority (sixty-three cases) the duration was seven to nine months.

As regards the technique of the abduction method, I have nothing new to add to what I already explained in my writings and at the London



Meeting in 1929. I found it best to modify the abduction apparatus by making the two hips independent of one another, so that one could at will graduate the degree of abduction in each limb separately.

### RESULTS

Out of the 119 cases I obtained complete cure in 113, that is in ninety-four and nine-tenths per cent. If from the six unsuccessful cases we exclude one, in which failure was due to the mother's neglect to carry out our directions, the percentage is increased to ninety-five and seven-tenths. Of the remaining five cases, all bilateral, in two, failure of the abduction treatment was on one side only. The unreduced hip was later reduced by the manipulative method. That leaves only two cases in which the method failed completely. These were two infants, aged three and five months respectively, who, in addition to double congenital dislocation of the hips, had club feet, and rigidity of the knees and elbows. In these two cases, manipulation also was quite unsuccessful.

Although the statistics which I have presented are not yet numerous enough to allow of a final decision as to the value of the method, yet I think that for the moment it justifies the following conclusion:

A method, which avoids all operative trauma, which dispenses with all anaesthesia, which is incomparably less risky and less complicated than that in common use, *such a method, in cases of congenital dislocation under twelve months of age, gives a high percentage of results anatomically and functionally perfect.*

Before concluding, I wish to consider the two fundamental criticisms, which have been made against the abduction method.

### TABLE II

#### CONGENITAL DISLOCATION OF THE HIP

GENERAL STATISTICS OF CASES TREATED AT THE ISTITUTO RIZZOLI  
FROM 1899 UP TO 1931

#### 3216 CASES

Females.....	2725	(84.7 per cent.)	Males.....	491	(15.2 per cent.)
Bilateral.....	1476	(43.8 per cent.)	Unilateral.....	1740	(54.1 per cent.)
Right side.....	1081	(33.6 per cent.)	Left side.....	659	(20.4 per cent.)

#### CASES TREATED WITH THE ABDUCTION METHOD

#### 119 CASES

Females.....	84	(70.5 per cent.)	Males.....	35	(29.4 per cent.)
Bilateral.....	52	(43.6 per cent.)	Unilateral.....	67	(56.3 per cent.)
Right side.....	50	(42.0 per cent.)	Left side.....	17	(14.2 per cent.)

It has been said that the practical value of this method can only be relative, since the dislocations are usually brought under the observation of the orthopaedic surgeon too late for such a method to be applied.

It seems to me that such an objection can only have weight with those who despair of the future of our speciality; I cannot believe that it can enter the mind of any modern orthopaedic surgeon. If heretofore we have not

troubled to recognize dislocations very early, or, in other words, to seek out predislocations, because we thought it unnecessary to begin treatment before the age of one year, now that it has been demonstrated that the results obtained by intervention below this age limit are incomparably better than those obtained after it, it is the duty of every orthopaedic surgeon to popularize this principle, and to spread among medical classes the knowledge of the chief signs of an early dislocation, and to insist on the routine x-ray examination of all new-born infants.

What today may seem the exceptional method, in the future will in all probability become the method of choice, and the orthopaedic surgeon will thus have taken a great step forward in the treatment of congenital dislocation.

Now let us pass to the second criticism. It is known that congenital dislocation can undergo spontaneous reduction. The figures proving this are not numerous,—forty-five cases according to Marconi's recent work; but the fact is indisputable.

Bearing this in mind, it has been said that it is highly probable that some of those cases, which I have designated predislocations, would have undergone spontaneous cure,—that is without the abduction treatment.

Although there is no lack of arguments to demonstrate the essential inconsistency of this criticism, I prefer to accept it as it is. But I cannot ignore the following considerations: Granting that some predislocations might reduce themselves spontaneously, who today, face to face with a clearly demonstrated case of predislocation, would feel himself justified in omitting the application of a harmless therapeutic measure, which is simple and inexpensive, and is calculated not merely to prevent and cure a dislocation under the most favorable conditions, but to avoid the two possibilities, which face every individual whose hips are not anatomically perfect? These two possibilities are:

1. The arthritic reaction, which may develop in the course of treatment, a reaction which we cannot prevent, because it is in great part dependent on obscure factors of constitutional nature, and which can only be avoided by very early treatment.

2. Subluxation, which is almost always overlooked and often neglected, until it becomes obvious at an age when no radical cure is available and it becomes the cause of the syndrome of arthritis deformans, which is only slightly amenable to therapeutic measures. Calot estimates subluxations as ten times more common than dislocations. From the statistics of the Istituto Rizzoli we conclude that forty per cent. of cases of arthritis deformans in the adult are based on congenital subluxations.

If, in view of these two possibilities, we have needlessly submitted a case of predislocation to a gentle and harmless form of treatment, when it might have been lucky enough to reduce itself spontaneously, this is not in itself a ground for discrediting a method, in which, according to our views, lies the *only secret which can improve the results of the treatment of congenital dislocation of the hip.*

# OPERATIVE FIXATION OF TUBERCULOUS HIPS IN CHILDREN \*

END-RESULT STUDY OF THIRTY-THREE PATIENTS FROM THE ORTHOPAEDIC  
DEPARTMENT OF THE CHILDRENS' HOSPITAL

BY JOHN C. WILSON, M.D., LOS ANGELES, CALIFORNIA

A review of the recent writings on the treatment of tuberculosis of the hip joint indicates that the trend is toward surgical fusion. It is generally agreed that a healed tuberculous joint will not permit a useful range of motion. Bony ankylosis of the affected joint is the ultimate objective with any form of treatment.

British surgeons have been strong advocates of conservative measures but Girdlestone in the Jones Birthday Volume states that fusion is always indicated in adults. Eighteen months of conservative treatment is recommended for children. A fusion is done if this does not give a free and painless range of motion. Mercer writes that conservative treatment is discouraging and recommends the Hibbs operation when destruction is extensive. Wade is not satisfied with conservative treatment but questions the advisability of fusion operations in children. Measures to ankylose the joints by surgical aid are advised for adults. Glissan states that ankylosis is the only cure, but does not consider operative methods to produce it. Bristow recommends operative treatment in certain cases irrespective of age. Hibbs's method is preferred.

Some of our more conservative American authors are advocating operative treatment to obtain ankylosis in adults. Henderson advises conservative treatment in children and operative measures in adults to obtain ankylosis. He does not suggest any particular type of operation.

While intra-articular operations are rather universally condemned, Key thinks that they are justifiable when coupled with a packing in of osteoperiosteal grafts between the ilium and neck of the femur. This treatment is recommended only for individuals over ten years of age. Farrell reports ten cases of intra-articular fusion by denuding the cartilage from the head of the femur and acetabulum with eighty to ninety per cent. of failures. He also states that an operation to be of any practical value must be applicable to children.

The idea of producing a bony ankylosis of the hip joint by an extra-articular procedure is not new. Albee in 1919 described a fusion of the hip by using tibial grafts as struts between the crest of the ilium and great trochanter. Kappis, in 1920, bridged from the crest of the ilium to the trochanter with an osteoperiosteal graft from the tibia. He reported a series of twenty cases in 1924, some of which were unsuccessful. Baron

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reported a plastic fusion operation in 1921. Flaps from the ilium and trochanter were overlapped and secured by an osteoperiosteal graft from the tibia. Haas in 1922 reported three cases in which fusion was obtained by implanting the great trochanter into the ilium without opening the joint capsule.

The Hibbs operation published in 1926 has become most popular, stimulating a wide-spread interest in the joint tuberculosis problem. Hibbs's operation is in principle a bone graft swung from the femoral trochanter to the ilium without complete interruption of the blood supply. Schumm in 1929 described an operation in which the graft, used to bridge the gap between the trochanter and ilium, is taken from the upper third of the femur. Ghormley in 1931 described an ingenious operation to produce ankylosis of the hip joint. A section of iliac crest is inserted into a slot carefully prepared in the trochanter and ilium, acting as a key. Abbott and Fisher call attention to the fact that extensive destruction of the head of the femur and acetabulum allow close approximation of the great trochanter and ilium. Such cases lend themselves to direct fusion between the ilium and trochanter after denudation of contacting bony surfaces and wide abduction. Osteotomy is done later and the callus is bent sufficiently to allow correction of the abduction deformity.

In 1927 the first iliofemoroplasty or pedicle-flap operation was described by the author. Stress was laid upon the fact that this was not a bone-grafting operation because the distal end of the flap retains its continuity. A part of the blood supply at least is undisturbed. While the operation has been described as extra-articular, this is not true in every detail. The joint capsule is opened to expose the neck of the femur but the joint surfaces are not invaded.

No large series giving end results of operations to ankylose tuberculous hips in children has been reported up to the present time. Albee reported thirty-one cases with very satisfactory clinical and functional results in all instances. This series includes one child aged three and one-half years, two aged four years, one aged eleven years, and one child age not stated. Out of these five cases, two are reported as having good results and two excellent.

Hibbs in 1926 gave a preliminary report of twenty cases, drawing no conclusions as to value of the operation. He observed that fusion first occurred between the trochanter, graft, and ilium, to be followed by consolidation in the area of disease. Solid ankylosis as demonstrated by clinical and x-ray examination was found in eighty to ninety per cent. of the cases. An operative mortality of five per cent. was reported. Thirty per cent. of the surgical wounds drained.

Kidner reported, in 1928, sixteen cases between four and fourteen years of age with firm bony union in eleven. The Hibbs operation was done. Four were cured, two were still under treatment, and one died from meningitis. He thinks twenty to forty degrees of flexion of the hip with a neutral position relative to abduction and adduction is the most

TABLE I

Case	Sex	DURATION OF SYMPTOMS	PREVIOUS OPERATIONS	AGE AT ILIOFEMOROPLASTY	SINUS	TISSUE	SUBSEQUENT OPERATIONS	ABSCESS
Case 1	F	3 years 6 months	0	7 years	0	0	0	0
Case 2	F	5 years	0	8 years 6 months	+	+	0	+
Case 3	M	2 years 3 months	0	10 years	0	0	0	0
Case 4	F	4 years	1st. Drainage abscess 2nd. Arthrodesis by fibular transplant	9 years 6 months	0	0	0	0
Case 5	M	7 years	0	10 years	0	+	0	+
Case 6	M	6 months	0	4 years	0	0	0	0
Case 7	F	4 years	0	9 years 6 months	0	0	0	0
Case 8	M	1 year	0	7 years	0	+	0	+
Case 9	F	Unknown	Intra-articular arthrodesis	6 years	0	0	0	0
Case 10	F	2 years	0	4 years 6 months	0	+	0	0
Case 11	M	1 year 8 months	0	10 years	0	+	0	+
Case 12	F	1 year	0	9 years	0	0	Aspiration of abscess over trochanter, 1 year 8 months after 1st operation. No drainage subsequently. Subtrochanteric osteotomy 4 years 8 months after iliofemoroplasty	+
Case 13	M	6 months	0	4 years 6 months	0	+	0	
Case 14	M	Unknown	1st. Fibular graft. 2nd. Reinsertion of fibular transplant	8 years	+	0	0	+
Case 15	F	5 months	0	8 years	0	+	New iliac flap 7 months after 1st operation	0
Case 16	F	2 years 6 months	Aspiration of abscess	7 years	+	+	0	+

TABLE 1—Continued

	DRAINAGE	PERIOD OF IMMOBILIZATION AFTER OPERATION	CLINICAL FUSION	X-RAY FUSION	POSITION—SHORTENING	NUTRITION	TIME SINCE FUSION
Case 1	0	Undetermined	+	+	Flexion 20°—Abduction 15° Rotation neutral Shortening 2 cm.	Good	7 years
Case 2	6 months post-operative	6 months	+	+	Flexion 20°—Abduction 10° Ext. rotation neutral Shortening 1 cm.	Excellent	6 years 3 months
Case 3	0	9 months	+	+	Flexion 50°—Abduction 10° Rotation neutral Shortening 2 cm.	Excellent	6 years
Case 4	0	Undetermined	+	+	Flexion 20°—Adduction 10° Rotation neutral Shortening 2 cm.	Excellent	6 years
Case 5	8 months post-operative	9 months	+	+	Flexion 15°—Abduction 10° Ext. rotation 15° No shortening	Good	5 years 5 months
Case 6	0	6 months	+	+	Flexion 40°—Abduction 10° Ext. rotation 30° Shortening 4 cm.	Excellent	5 years 4 months
Case 7	0	10 months	—	+	Flexion 15°—Abduction 15° Rotation 10° Shortening 1 cm.	Excellent	5 years 4 months
Case 8	6 months post-operative	9 months	+	+	Unknown	Unknown	5 years 3 months
Case 9	5 years 3 months after operation. Draining slightly at present. Hip solid	6 months	+	+	Flexion 20°—Adduction 10° Rotation neutral Shortening 10 cm.	Excellent	5 years 3 months
Case 10	1 year 8 months	2 years	+	+	Flexion 35°—Abduction 15° Ext. rotation 10° No shortening	Excellent	5 years 2 months
Case 11	6 months	1 year	+	+	Flexion 50°—Abduction 15° Ext. rotation neutral Shortening 4 cm.	Excellent	5 years
Case 12	0	8 months	+	+	Flexion 10°—Abduction 5° Rotation neutral Shortening 1 cm.	Excellent	5 years
Case 13	1 year 8 months	1 year 8 months	+	+	Flexion 15°—Abduction 10° Rotation neutral Shortening 1 cm.	Good	4 years 8 months
Case 14	3 months	5 months	+	+	Flexion 20°—Abduction 10° Rotation neutral Shortening 2 cm.	Excellent	4 years 6 months
Case 15	6 months following 2nd operation	6 months after 2nd operation	+	+	Flexion 15°—Abduction 10° Rotation neutral Shortening 1 cm. after osteotomy	Good	4 years
Case 16	1 year postoperative	1 year	Failure	Flap absorbed. Extensive acetabular destruction 1 year after operation	Not fused	Fair	3 years 11 months

TABLE I — *Continued*

	SEX	DURATION OF SYMPTOMS	PREVIOUS OPERATIONS	AGE AT ILIOFEMOROPLASTY	SINUS	TISSUE	SUBSEQUENT OPERATIONS	ABSCESS
Case 17	M	2 years	0	4 years	0	+	0	0
Case 18	M	1 year	0	5 years	0	+	0	+
Case 19	M	2 years 4 months	0	9 years	0	0	0	+
Case 20	M	3 years	0	8 years	0	+	0	+
Case 21	F	1 year	0	6 years	0	+	0	0
Case 22	F	1 year 2 months	Biopsy	4 years	0	+	0	0
Case 23	M	6 months	Biopsy	9 years	1st 0 2nd 0 3rd +	+	2nd operation 6 mos. after 1st. A new iliac flap 1 yr. 6 mos. after 1st operation	1st 0 2nd 0 3rd +
Case 24	M	1 year 4 months	0	8 years	0	+	Drainage of abscess 1 yr. 9 mos. after fusion and excision of abscess wall	0
Case 25	M	9 years	Drainage of abscess	10 years	+	+	1st. Reinsertion of flap into trochanter 1 yr. after fusion. 2nd. Femoral graft interlocked with iliac flap 26 months later	1st +
Case 26	M	3 years	0	6 years	+	0	0	+
Case 27	F	5 months	Aspiration of abscess	3 years	0	Guinea-pig inoculation positive	0	0
Case 28	M	2 years	0	8 years	0	0	New flaps split from femur and ilium 3 months after 1st operation	+ at both operations
Case 29	F	4 months	0	8 years	+ over sacrum	+	0	+
Case 30	F	9 years	0	14 years	0	0	0	0
Case 31	M	1 year	0	7 years	0	0	0	0
Case 32	F	7 years	Biopsy	13 years	0	+	0	0
Case 33	F	1 year	0	2 years 2 months	0	+	0	0

TABLE I—Continued

	DRAINAGE	PERIOD OF IMMOBILIZATION AFTER OPERATION	CLINICAL FUSION	X-RAY FUSION	POSITION-SHORTENING	NUTRITION	TIME SINCE FUSION
Case 17	3½ years	3½ years	+	+	Flexion 20°—Abduction 10° Ext. rotation 30° Shortening 2 cm.	Dead 3½ years after iliofemoroplasty of generalized tuberculosis	3 years 6 months
				2 years; 4 months after iliofemoroplasty			
Case 18	2½ years	1 year 8 months	+	+	Flexion 15°—Abduction 10° Ext. rotation 10° Shortening 2 cm.	Good	3 years 3 months
Case 19	4 months	6 months	+	+	Flexion 15°—Abduction 10° Ext. rotation neutral Shortening 2 cm.	Good	3 years 2 months
Case 20	3 years. Still draining	3 years	+	+	Flexion 15°—Abduction 10° Ext. rotation 20° Shortening 2 cm.	Good	3 years
Case 21	6 weeks	1 year	+	+	Flexion 25°—Abduction and adduction neutral Ext. rotation 10° Shortening 1 cm.	Excellent	2 years 9 months
Case 22	0	11 months	+	+	Flexion 15°—Abduction 15° Rotation neutral Shortening 1 cm.	Good	2 years 8 months
Case 23	Drained 1½ years after 2nd operation to time of death	2 years	Failure	X-ray shows pro- gressive destruction	Dead	Dead	2 years 5 months
Case 24	5 months	10 months	+	+	Flexion 20°—Abduction 15° Ext. rotation 30° Shortening 2 cm.	Excellent	2 years 1 month
Case 25	4 months	8 months after 3rd operation	Failure	X-rays show no fu- sion between flap and trochanter	Flexion 20°—Abduction 10° Rotation neutral Shortening 4 cm.	Excellent	2 years
Case 26	1 year 10 months	1 year 2 months	+	+	Flexion 20°—Abduction 15° Ext. rotation 20° Shortening 1 cm.	Good	1 year 10 months
Case 27	1 year 4 months	1 year	+	+	Flexion 20°—Abduction 10° Ext. rotation 20° Shortening 2 cm.	Good	1 year 5 months
Case 28	Draining 1 yr 4 months. Still draining	1 year 4 months. Still immobilized	Failure	Flap absorbed	Not fused	Unknown	1 year 4 months
Case 29	1 year 2 months. Still draining	11 months	+	+	Flexion 15°—Abduction 15° Rotation neutral Shortening 2 cm.	Good	1 year 2 months
Case 30	0	6 months	+	+	Flexion 15°—Abduction 10° Rotation neutral Shortening 2 cm.	Good	8 months
Case 31	0	7 months	Failure	Flap absorbed	Not fused	Excellent	7 months
Case 32	Draining 10 months. Still draining	8 months	+	+	Flexion 15°—Abduction 15° Rotation neutral Shortening 2 cm.	Excellent	10 months
Case 33	0	4 months. Still in cast	Failure	Flap absorbed	Not fused	Good	4 months



useful position. Early operation is advised and abscesses are not considered a contra-indication if sinuses are not present.

Schumm stated in 1929 that he had operated successfully upon nine cases in children.

Through a personal communication from Z. B. Adams it is possible to report that ten patients at the Lakeville Sanatorium, between the ages of three and fifteen years, suffering from tuberculosis of the hip joint, have been operated upon during the past two years by the pedicle-flap method. Five of the patients now have a solid fusion of the diseased joints.

### *Indications for Operation*

Iliofemoroplasty is suitable for any child, irrespective of age, who is suffering from tuberculosis of the hip joint and is known to be a good surgical risk. Abscesses with or without sinuses should not dissuade one from attempting surgical ankylosis of the diseased joint. It is well to avoid the tracts or openings of the sinuses during operation to avert unnecessary dissemination of infection. Extensive destruction of the femoral head and acetabulum simplifies the pedicle-flap operation because of the ease with which the iliac flap is placed into the trochanteric cleft.

### *Biopsy*

Fixation by extra-articular fusion must be done early if the structures comprising the joint are to be preserved. Although the history and clinical findings are indicative of a joint inflammation, the nature of the infecting agent may not be clear, and joint tissue should be removed for histological study or for animal inoculation. The function of the joint will not be jeopardized if the infection proves to be non-tuberculous. On the other hand the presence of typical tubercles in the tissue, with or without bacilli, or tuberculosis in an inoculated animal confirms a diagnosis of joint tuberculosis and justifies immediate fusion.

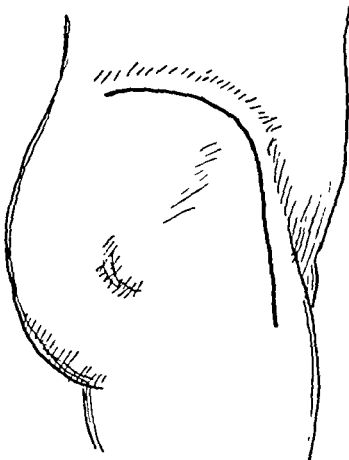


FIG. 1  
Line of incision.

### *Description of Operation*

Iliofemoroplasty was evolved as the result of unsuccessful attempts to ankylose hips by the intra-articular method and later by autogenous tibial and fibular transplants. Tibial transplants fused to the ilium promptly, but failed to unite with the femur. The fibula fused to the ilium, but the shaft of the bone was absorbed. This was attributed to the fact that the entire shaft was used as a transplant. The absence of raw surfaces may have inhibited revascularization of the graft.

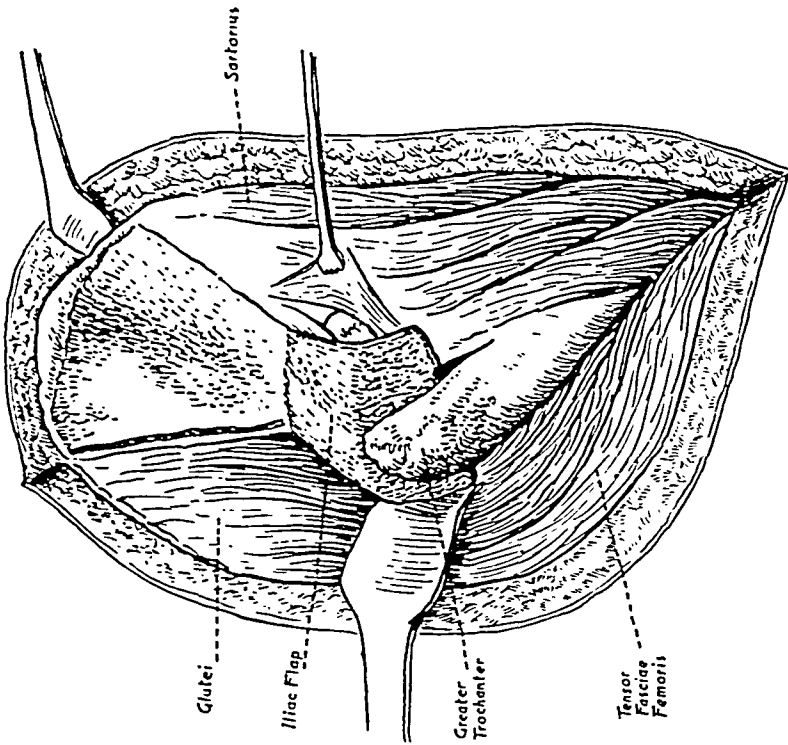


FIG. 3

Iliac flap inserted into trochanteric cleft.

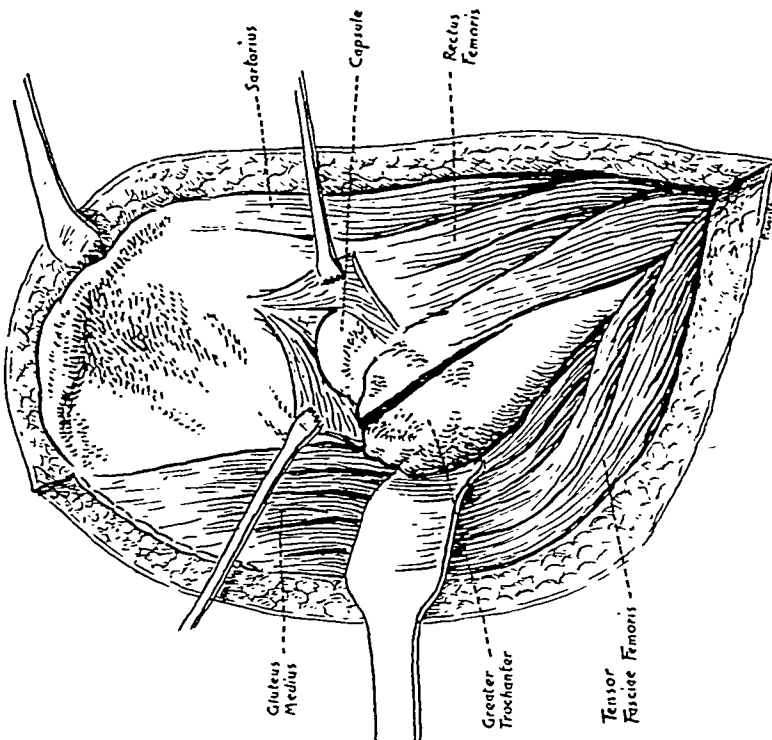


FIG. 2

Gluteus medius and minimus retracted, capsula opened, ilium exposed, and greater trochanter and shaft of femur split.

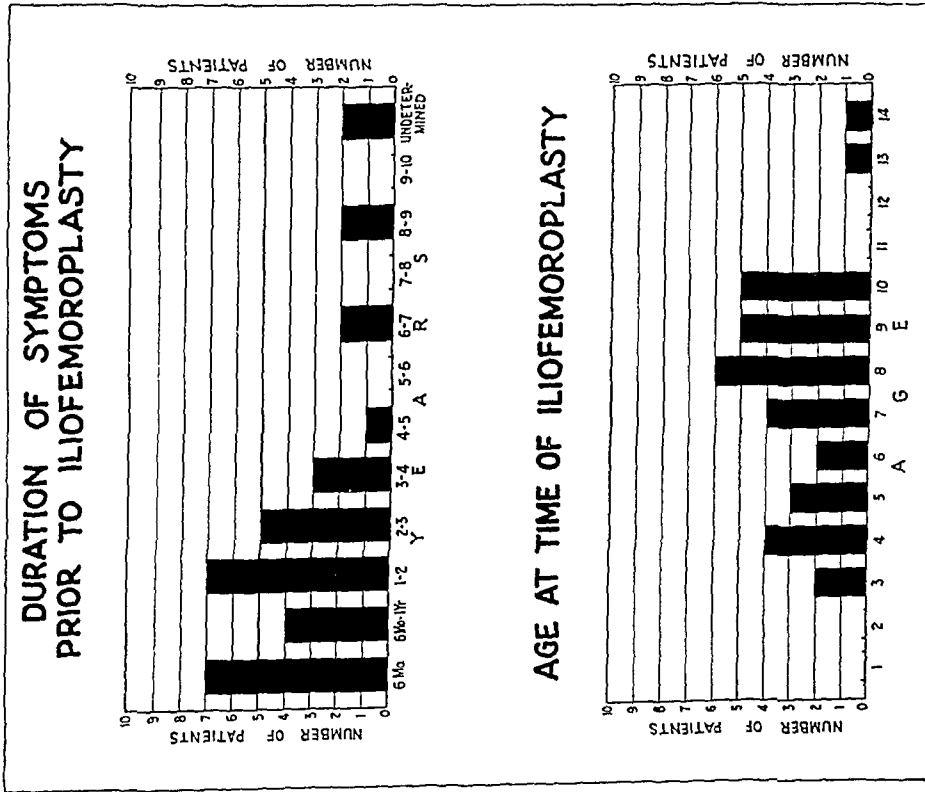


Fig. 4

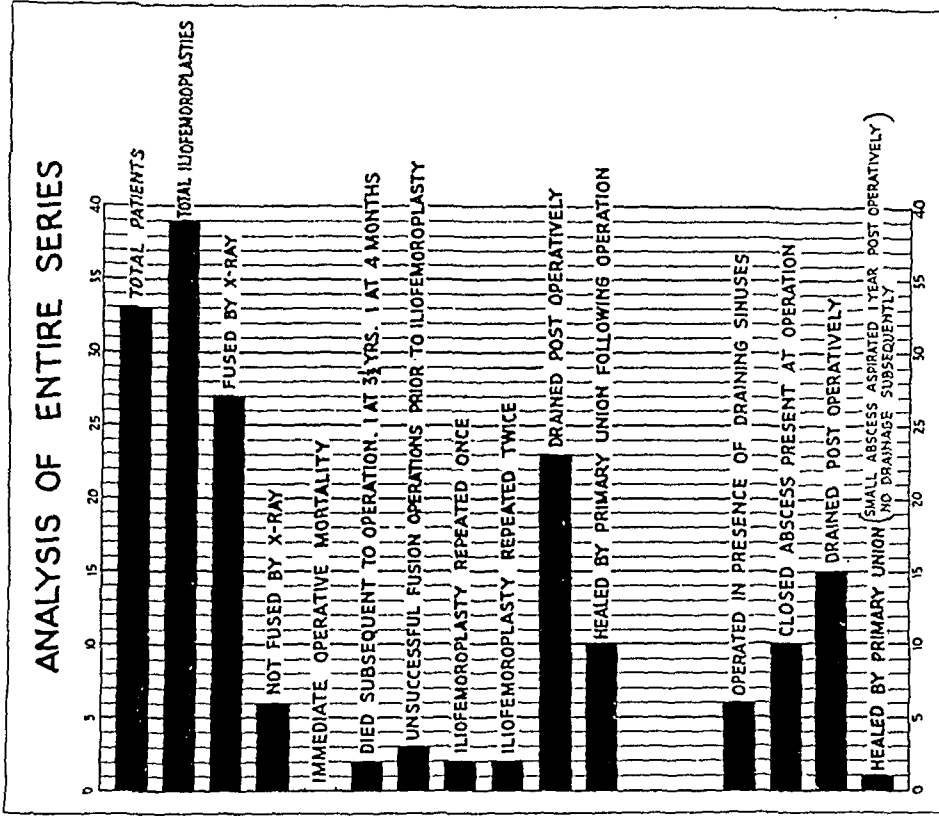


Fig. 5

The capsule of the hip joint is exposed through a liberal antero-lateral incision. The muscular attachments to the great trochanter are freed with a blunt dissector. The epiphysis of the trochanter must be displaced if it has not ossified, because if cartilaginous it endangers the nutrition of the bone flap. The shaft of the femur should then be exposed for a distance of about six centimeters. This will aid in the preparation of the trochanteric cleft. The joint capsule is split on its superior aspect, the anterior superior attachment to the ilium freed and well retracted. The great trochanter is next split for a distance of five centimeters in the longitudinal axis of the femur. A very thin osteotome is used to reflect a fan-shaped section of the outer cortex of the ilium, the base of the fan just above the margin of the acetabulum remaining attached. By exercising a little caution the flap may be turned into the trochanteric cleft by bending the pedicle. This is especially true in young children, as the bone is very flexible and not easily broken. A greenstick fracture of the flap happens occasionally, but the blood supply is not necessarily interrupted.

Since the periosteum of the ilium is removed with the gluteal muscles, replacement of the muscle flap brings the periosteum and fresh bone surfaces in contact. A solid pyramidal section of bone is the result, the neck of the femur forming the base of the pyramid.

After closure of the wound the patient is placed in a previously prepared, well dried and warmed, bivalved, long, double spica cast.

#### *Postoperative Care*

Postoperative convalescence may not differ from that following any other bone or joint operation. Wounds of ten patients healed by primary union. In seventeen of the patients who did not have sinuses at operation the wounds subsequently drained. Abscesses were encountered at operation in ten of the seventeen. The general reaction to the dissemination of infection was not great, and, although there was a considerable variation between morning and evening temperatures, the patients showed no severe toxic symptoms from the treatment.

The convalescence of the patients in whom fusion was done in the presence of draining sinuses may be made less difficult by preparing for dressings at the time of operation. The discharge from old sinuses must

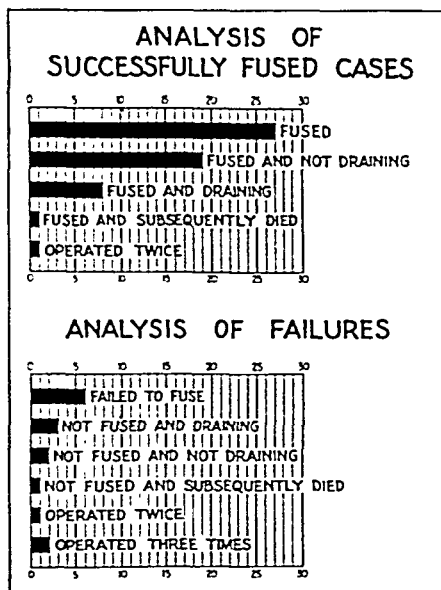


FIG. 6

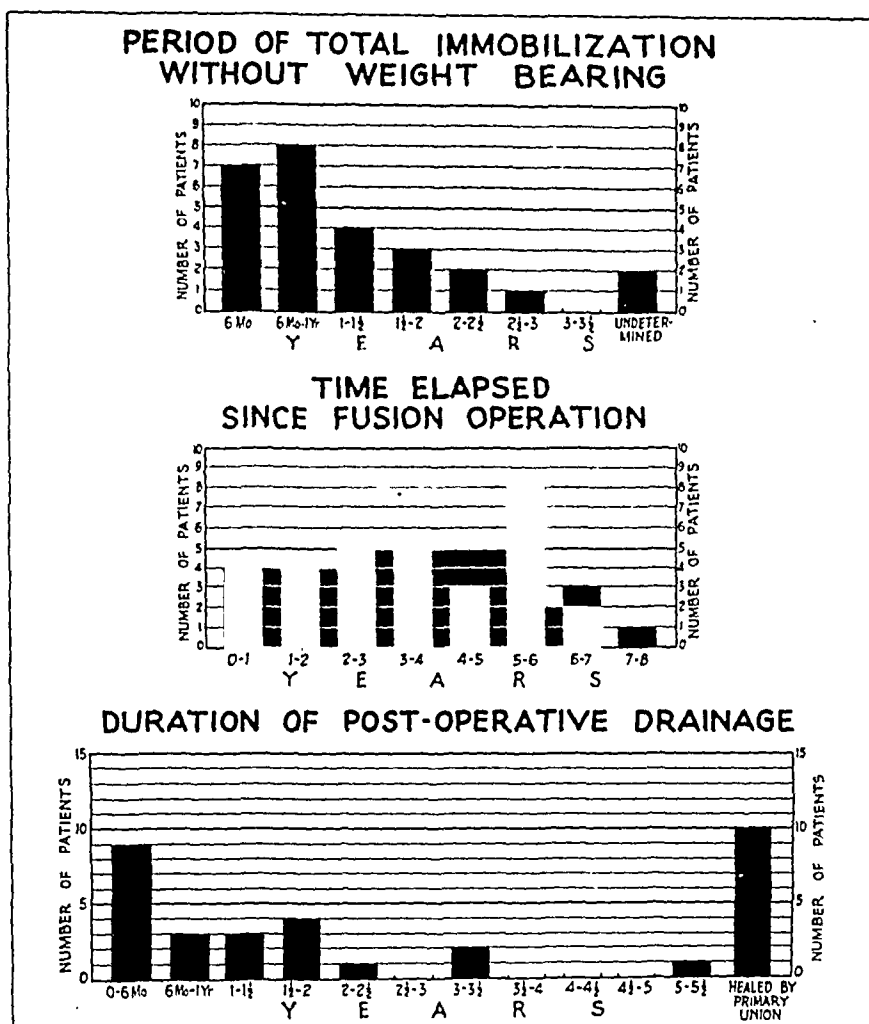


Fig. 7

not contaminate the operative wound. The septic temperature curves, which lasted in one instance (Case 20) as long as six months, are indicative of the severe febrile postoperative reactions which occurred in four of the patients operated upon in the presence of abscesses or draining sinuses. It was noted that the drainage was of shortest duration in those patients having one or more sinuses which drained posteriorly through the buttock or thigh.

No definite rules may be laid down for the length of postoperative immobilization and recumbency. In general, it is thought best to keep the fused hip fixed in a double spica until union is clinically firm. This is not an infallible dictum and was modified in certain cases, free from pain or muscle spasm, where a few degrees of motion existed. Weight-bearing with the hip protected by a short spica hastened bony ankylosis of the diseased joint in these particular instances. All hips were protected until fusion could be demonstrated by x-ray. Other measures—such as sunshine, fresh air, cod-liver oil, and heliotherapy—are invaluable adjuncts, for after all joint tuberculosis is a local manifestation of a constitutional disease.

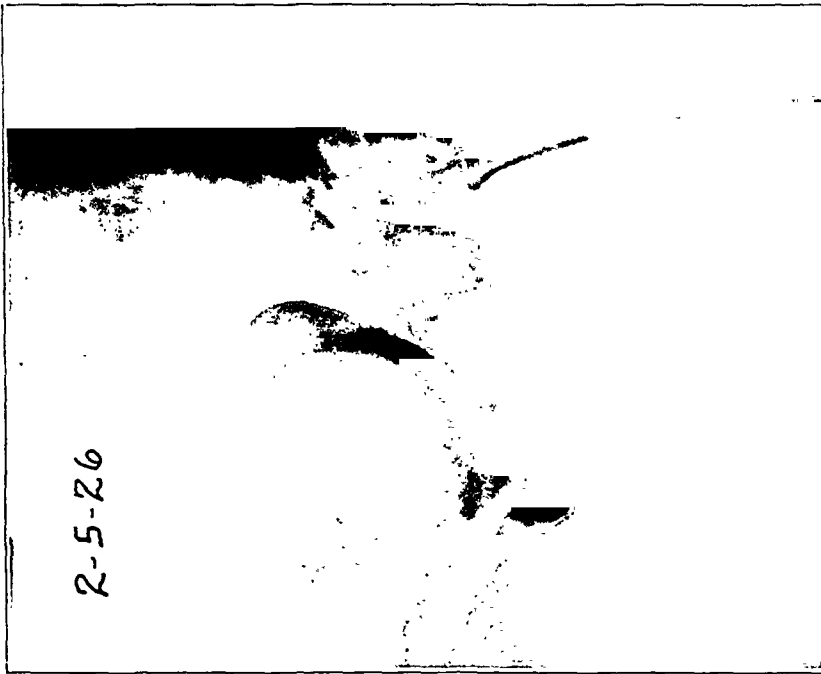


FIG. 8-B  
Case 9

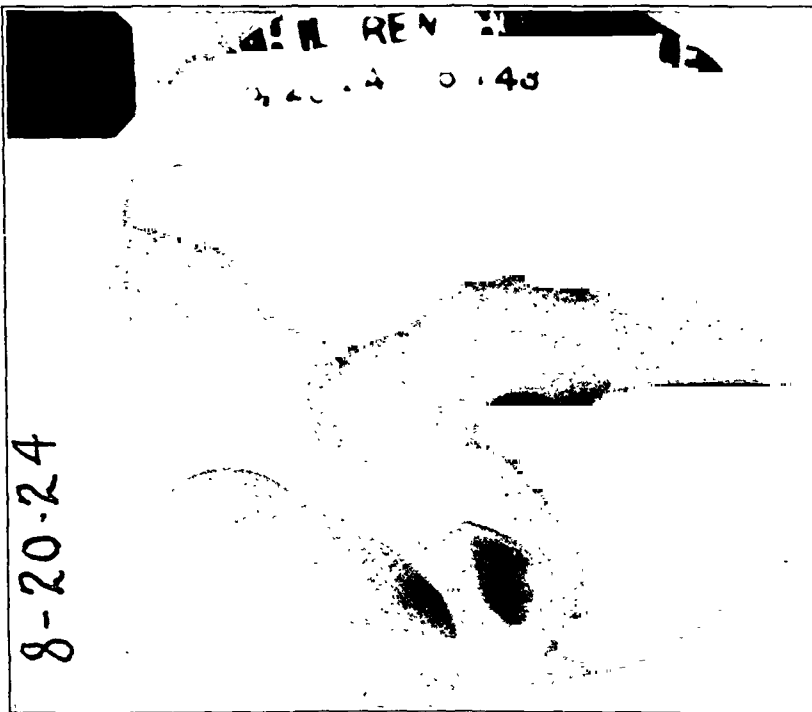


FIG. 8-A  
Case 9

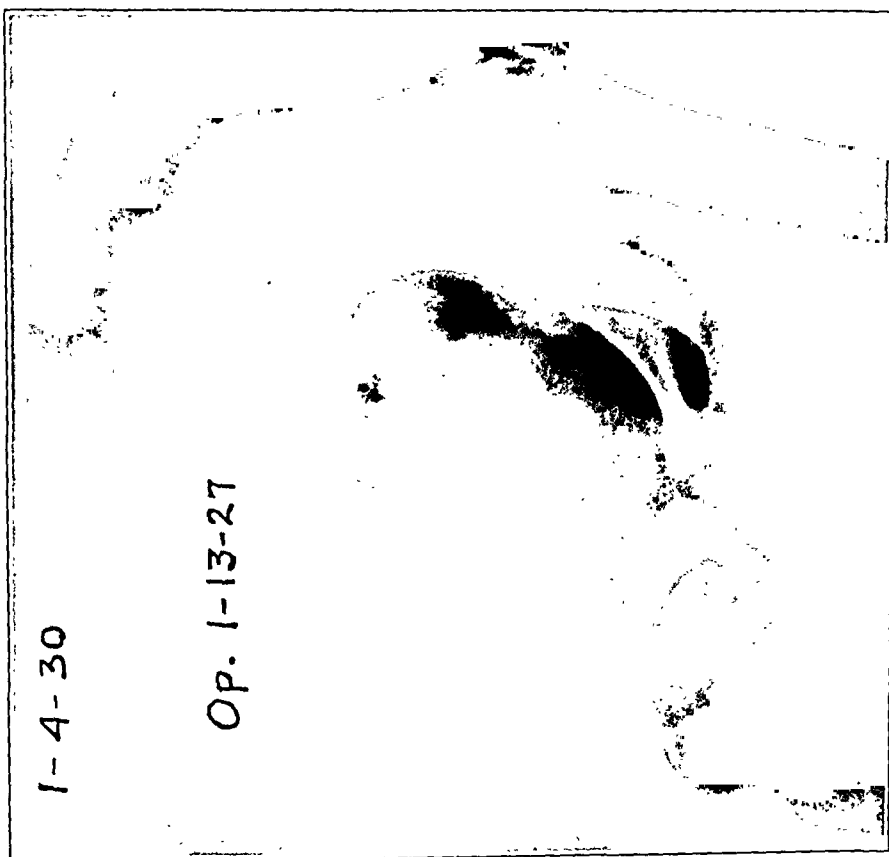


FIG. 8-D  
Case 9

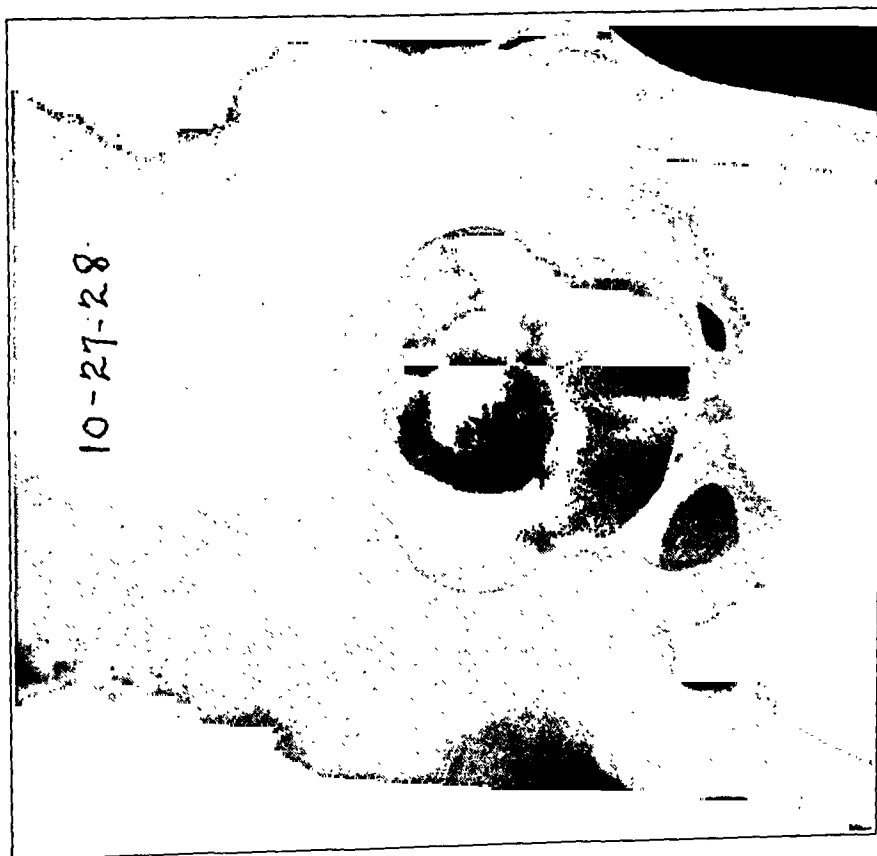


FIG. 8-C  
Case 9

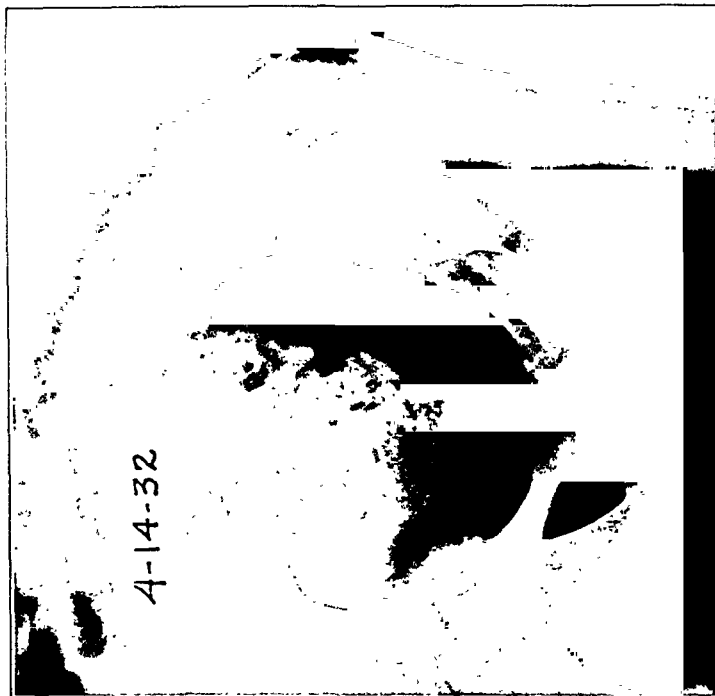


FIG. 8-F  
Case 9

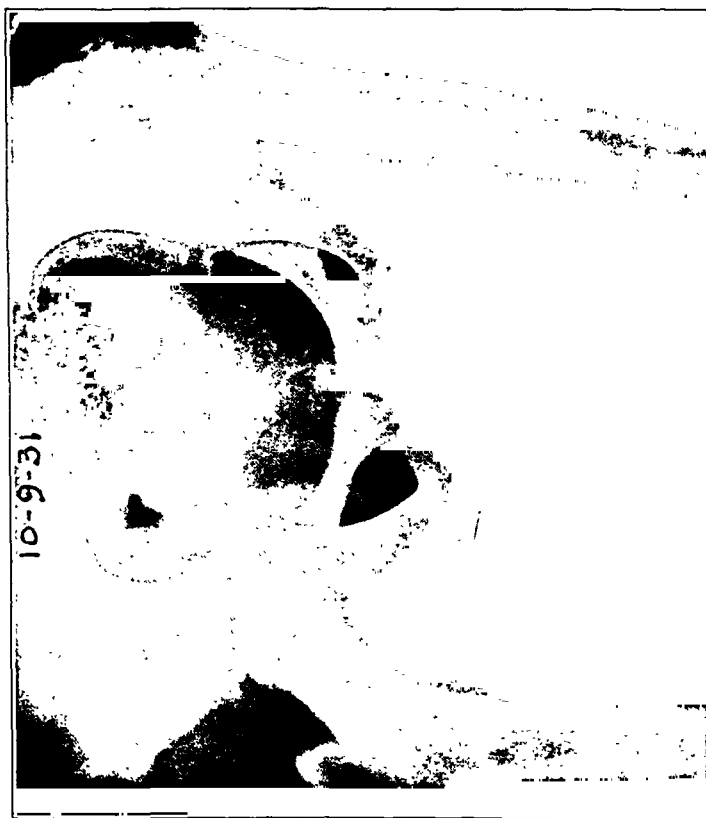


FIG. 8-E  
Case 9



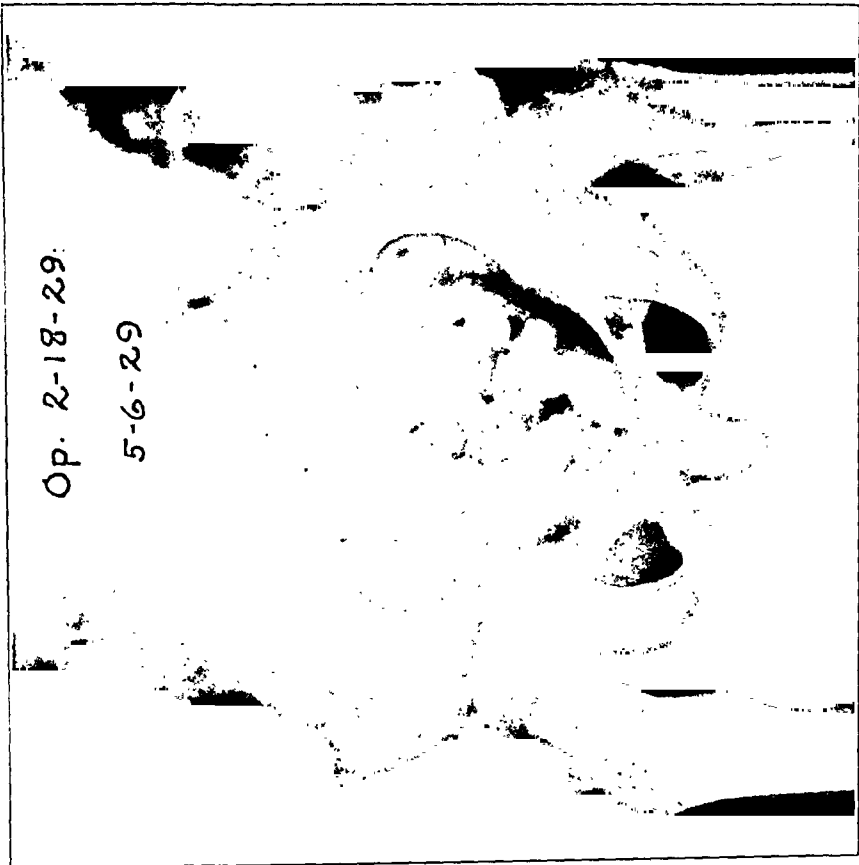


Fig. 9-B  
Case 19

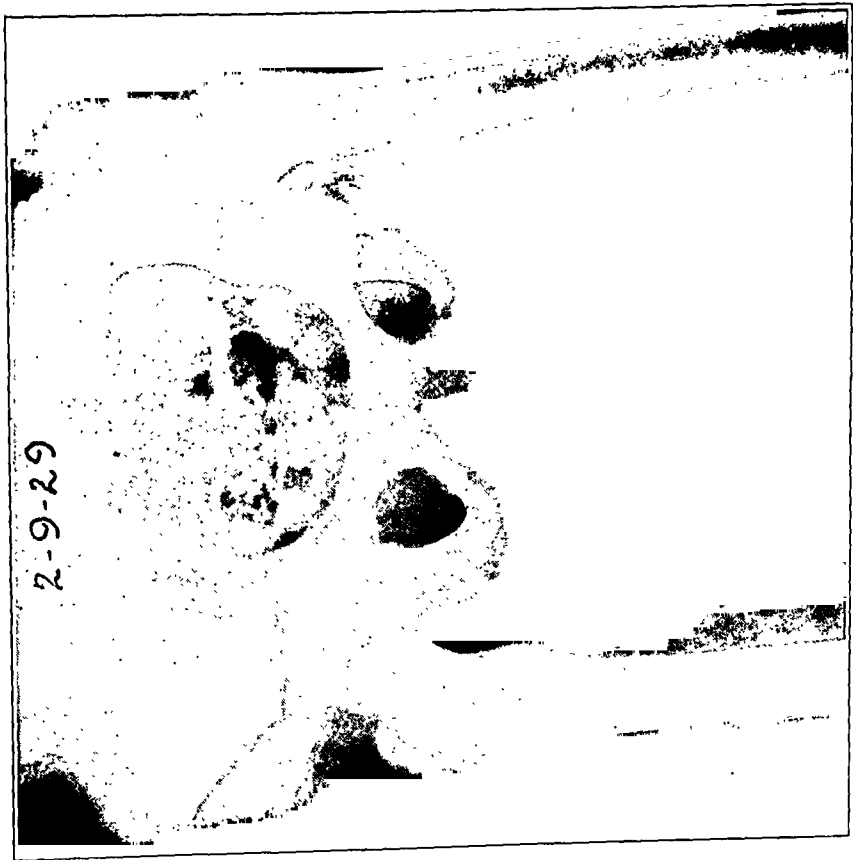


Fig. 9-A  
Case 19



FIG. 9-D  
Case 10

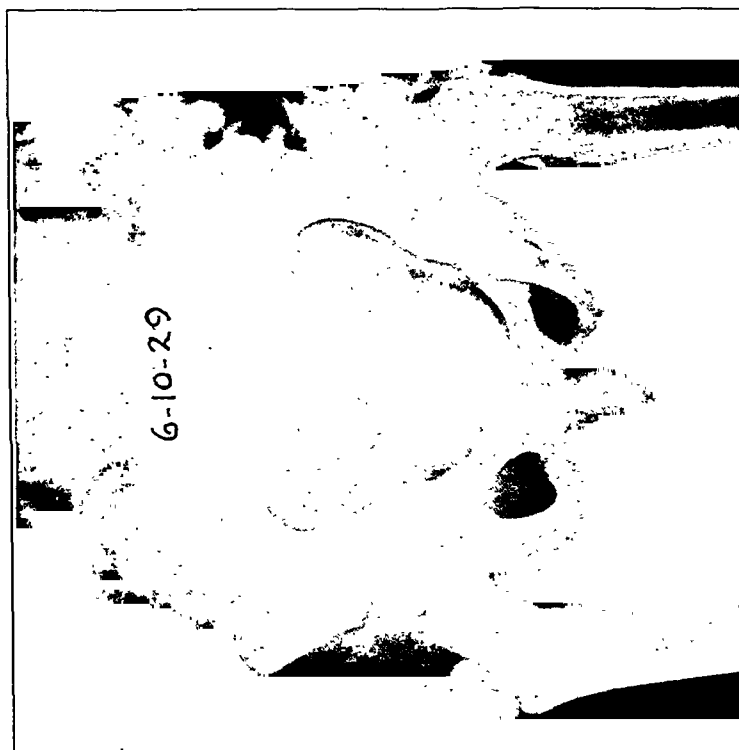


FIG. 9-C  
Case 10

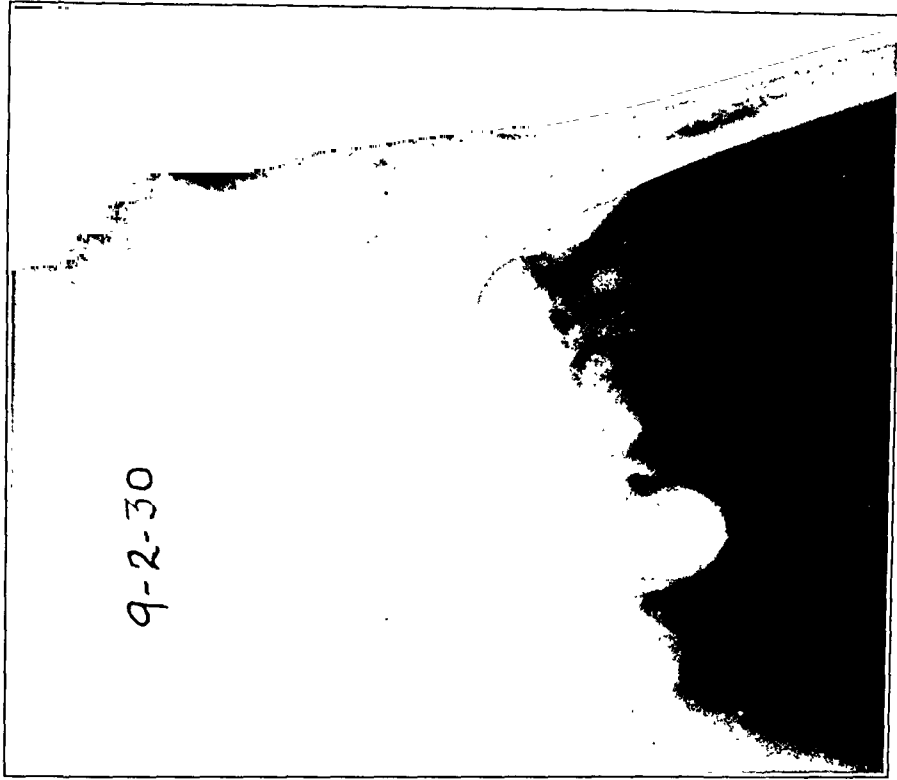


Fig. 10-B  
Case 24

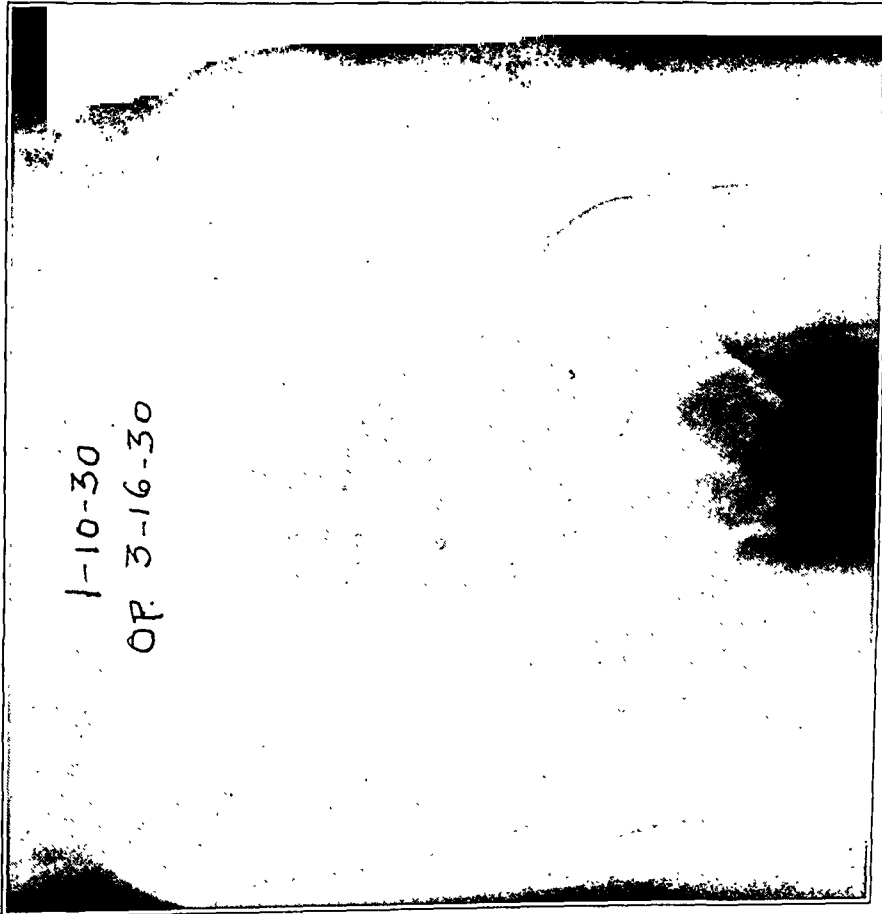


Fig. 10-A  
Case 24



FIG. 10-D  
Case 24



FIG. 10-C  
Case 24

### *Age and Sex*

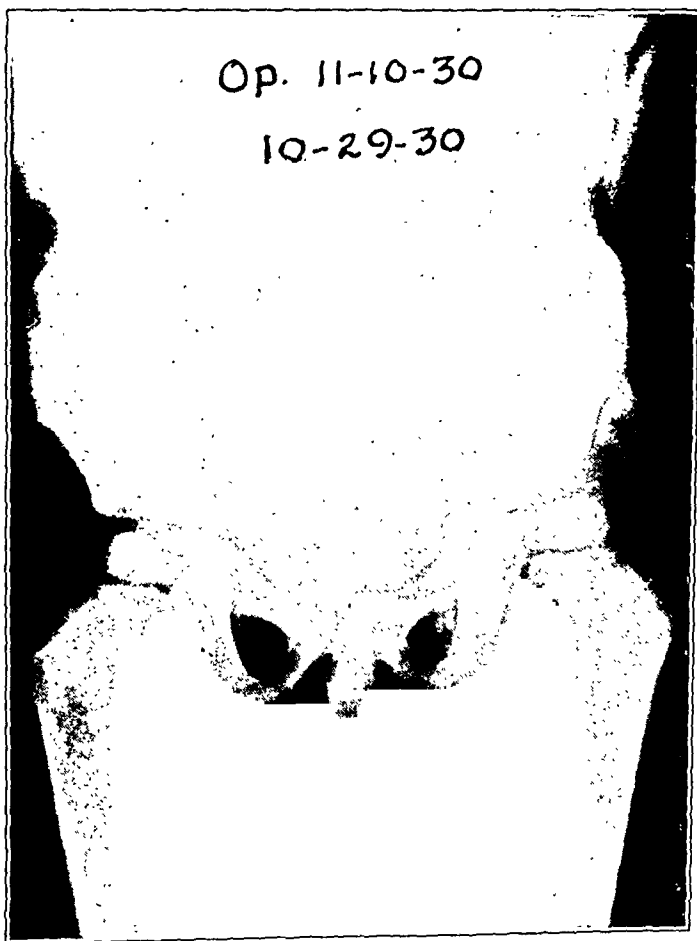
The youngest child in this series was three and the oldest fourteen years of age. Sixteen females and seventeen males were affected, indicating that sex did not influence the development of the disease.

### *Previous Treatment*

Conservative treatment of some sort had been given to all of these patients, but in most cases it had not been efficiently carried out. While one patient (Case 26) had been in an institution, supposedly immobilized by traction for two years, there was no evidence that this treatment was effective. A study of the x-rays taken during traction showed a rapid progression of the disease. An unsuccessful attempt had been made to fuse the hip in Case 4 by an extra-articular fibular transplant. An erosion of the cartilage of the acetabulum and head of the femur did not cause an ankylosis of the joint in Case 9. A fibular strut fused solidly to the ilium in Case 14, but absorbed at the point of trochanteric implantation. A second attempt to produce fixation of the hip by reimplanting the graft into the great trochanter was unsuccessful.

### *Sinuses*

Discharging sinuses are not a contra-indication to the pedicle-flap operation. Six of the patients who are included in this report were operated upon in the presence of draining sinuses.



### *Tissue Examination*

No cases of doubtful diagnosis were fused without a confirmation of the existence of tuberculous disease of the hip joint by microscopic examination of tissue or by animal inoculation. The presence of joint tuberculosis was verified by microscopic tissue examination in nineteen cases, and by guinea-pig inoculation in one case.

FIG. 11-A  
Case 27

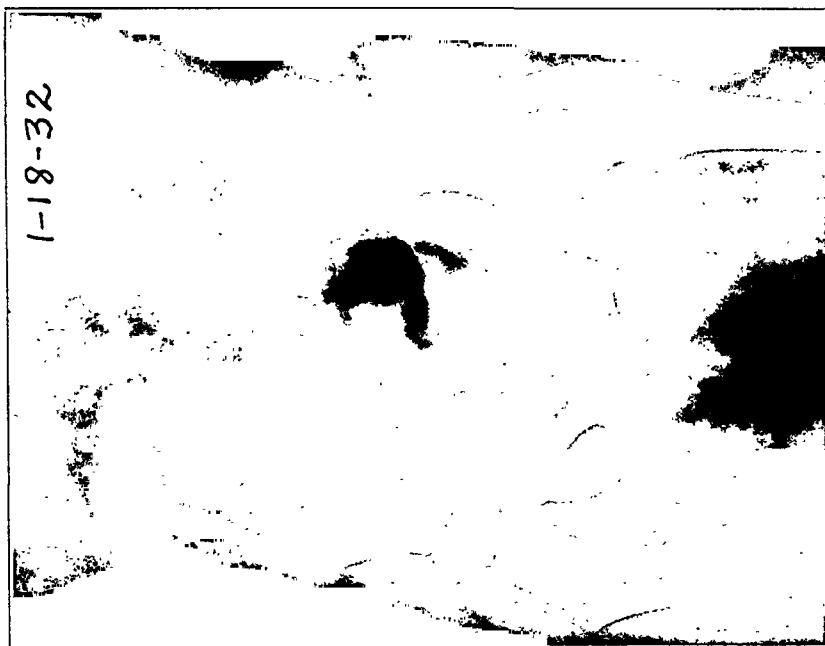


Fig. 11-C  
Case 27

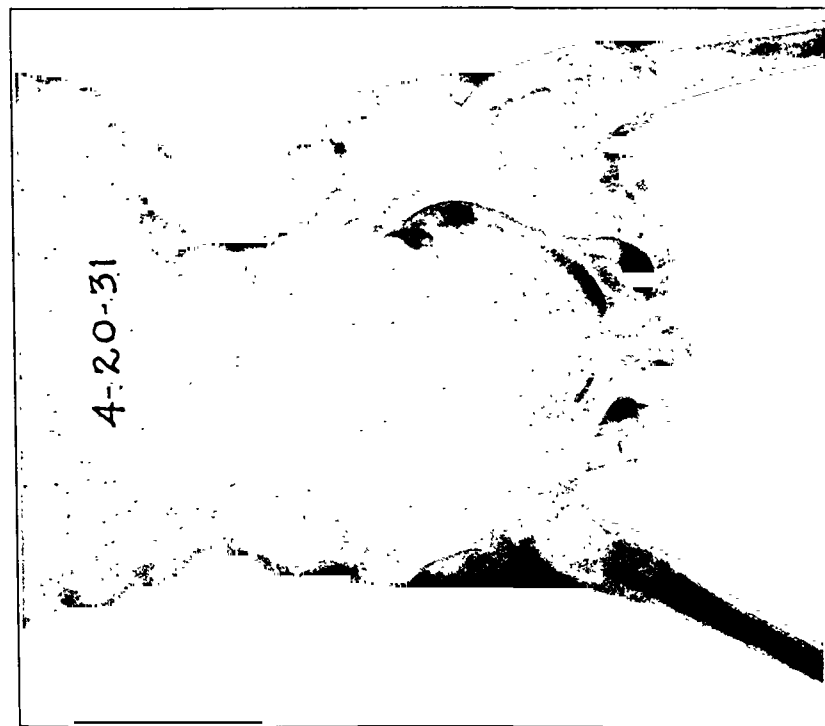


Fig. 11-B  
Case 27

*Subsequent Operations*

A cold abscess over the greater trochanter was aspirated one year and eight months following the fusion operation in Case 12. This abscess cavity did not refill after the aspiration. A subtrochanteric osteotomy was done four years and eight months after iliofemoroplasty to correct a flexion and adduction deformity of the thigh. In Case 15 a second operation was done seven months after the first; a new graft was turned down from the ilium. In Case 23 it was certain, six months after the first operation, that the hip would not fuse. A second iliofemoroplasty was then done, and the graft again absorbed. A third fusion was attempted one year and six months after the first operation. This patient died four months later of miliary tuberculosis without a fusion of the hip joint.

In Case 24, while apparently in the best of health, the patient developed a large abscess between the skin and deep fascia one year and nine months after a fusion operation, and eleven months after solid ankylosis of the joint. The cavity was injected with lipiodol solution for

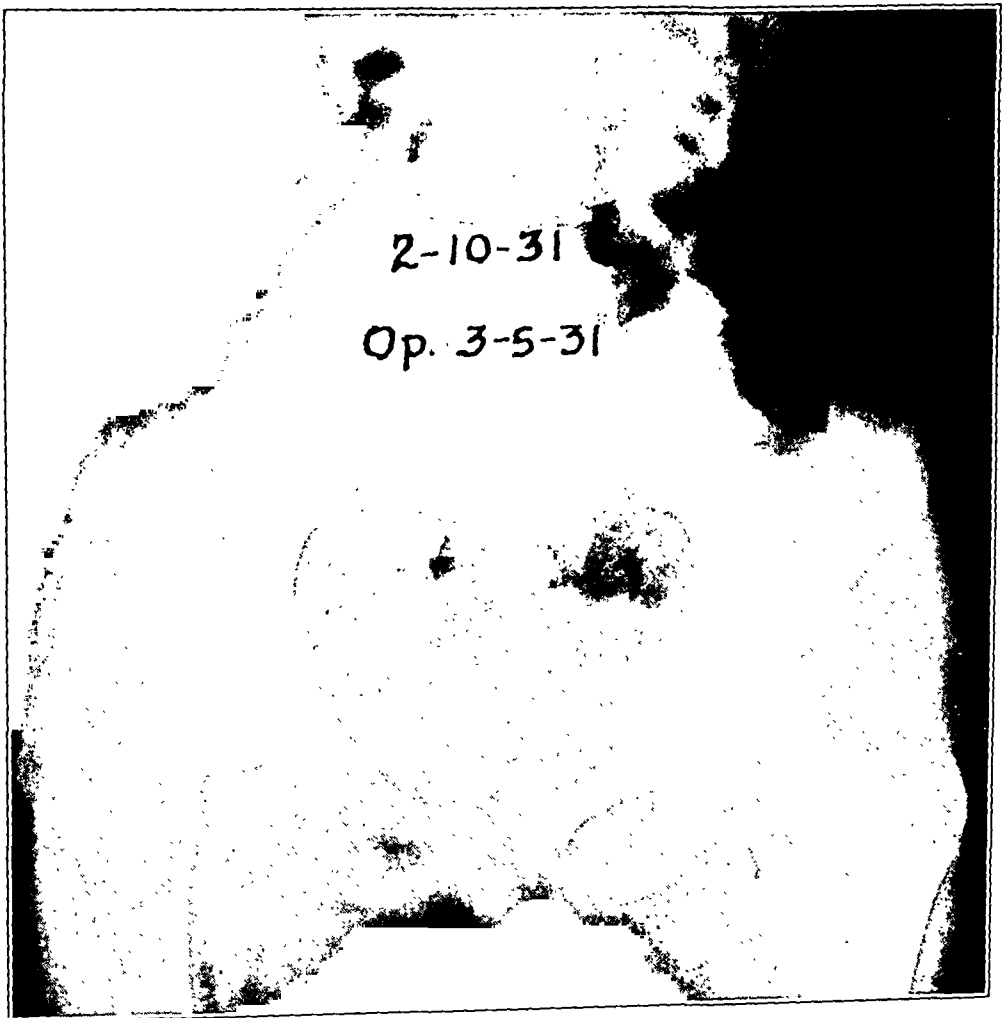


Fig. 12-A  
Case 29

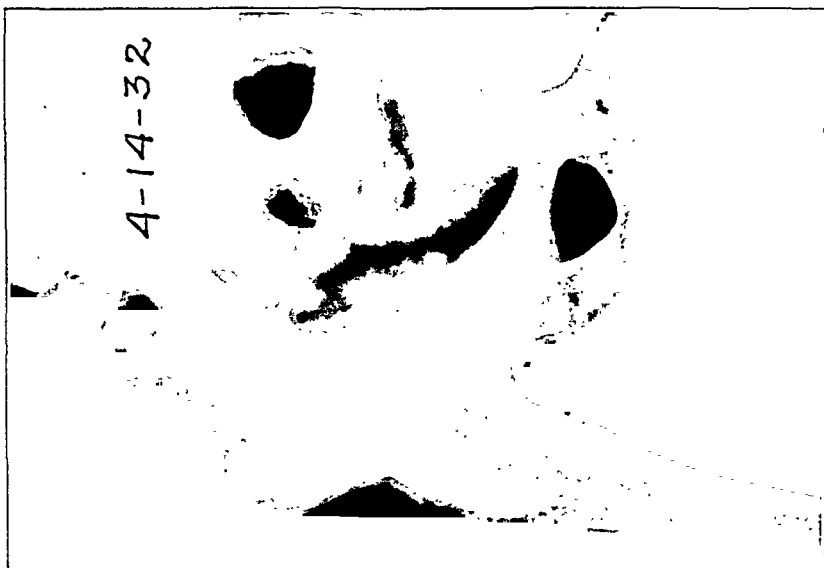


Fig. 12-C  
Case 29

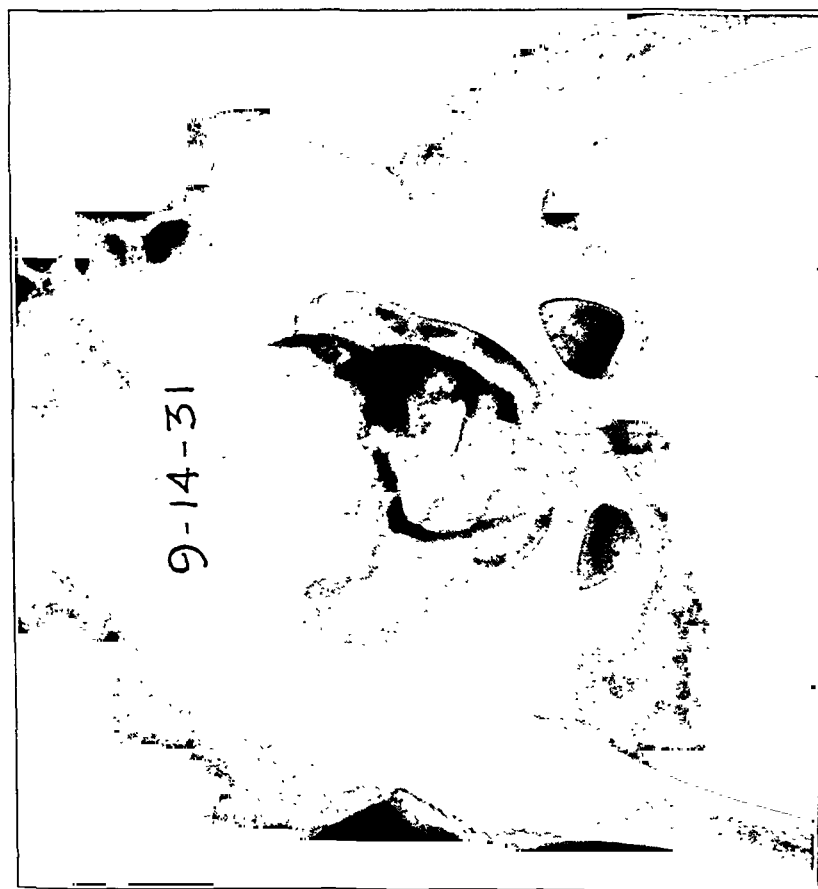


Fig. 12-B  
Case 29



x-ray examination, but no connection could be demonstrated between the abscess cavity and the hip joint. The wall of the abscess was carefully excised and the wound healed by primary union. Microscopic examination of the wall of the abscess showed typical tubercles. The iliac flap was reinserted into the trochanter one year after the first operation in Case 25; this did not produce fixation of the joint, so that a femoral graft was interlocked with the flap from the ilium two years and two months after the initial operation.

A second iliofemoroplasty was done in Case 28 three months after the first operation, because x-ray examination indicated a complete absorption of the flap without any apparent healing of the diseased area.

### *Abscesses*

Closed abscesses were encountered outside of the hip-joint capsule in ten patients. They varied in size, holding from thirty to two hundred cubic centimeters of pus. The exudate was carefully wiped away with as little contamination of the wound as possible, and disregarded in the later steps of the operation. No abscess was found in Case 23 at the first and second operations, but a definite abscess was present at the time of the third attempt at fusion which also terminated in a failure. Abscesses were found at both operations in Case 28.

### *Postoperative Drainage*

Twenty-three of the operative wounds failed to heal by primary union. The duration of the drainage period has varied from six weeks (Case 21) to five years and three months (Case 9). In fact, Case 9 is not healed at the present time, but the hip is firmly ankylosed, and the child is in excellent physical condition.

### *Period of Immobilization*

The shortest period of immobilization in the successful cases was five months (Case 14) and the longest three years (Case 20). Seven patients were immobilized in plaster for six months or less; eight patients for more than six months but not exceeding one year; seven patients were in plaster for more than one year but not exceeding two years. Three patients required immobilization for more than two years but less than three years. The length of the period of fixation could not be determined in two cases.

### *Clinical Ankylosis and X-Ray Fusion*

A definite line of distinction has been drawn between clinical fixation of the joint and fusion as demonstrated by x-ray. Many of the patients were clinically well before complete consolidation of the diseased area could be demonstrated by the x-ray. The hips of twenty-seven patients are solidly fused by both clinical and x-ray examination. The graft absorbed in Case 16, and a marked increase in the destruction of the acetabulum may be seen in the x-ray films taken one year following the pedicle-flap operation. In Case 23 the patient died two years and five

months after the second operation without obtaining ankylosis of the hip. Case 25 is in excellent physical condition; there is no pain in the hip, but the hip joint allows a few degrees of motion. This case has been classified as a failure. The x-ray showed absorption of the flap in Case 28 one year and four months following the operation. Case 31 by x-ray showed absorption of the flap in seven months and Case 33 in four months.

### *Position of Ankylosis*

A careful study of the patients with regard to gait, walking, standing, and sitting indicates that the best functional result is obtained when the hip is flexed in a position of fifteen to twenty degrees of flexion, with not more than ten degrees of abduction and without internal or external rotation. It may be necessary to modify this statement after another ten years have elapsed and these children reach adult life.

Failure to correct the external rotation of the thigh, allowing the hips to fuse with as much as thirty degrees of outward rotation, has occurred too frequently in this group of patients.

The shortening is apparently determined by the amount of epiphyseal destruction at the time of fusion. There is no evidence to indicate that the growth of the femur is retarded by fusion. Rapid healing of the disease aids growth by preservation of the remnants of epiphyseal cartilage. The greatest amount of shortening (10 centimeters) was found in Case 9 which exhibited extensive bone destruction as seen by x-ray, and many discharging sinuses. Two centimeters is the average amount of shortening and is readily corrected by holding the foot in a little equinus, or with a lift on the heel of the shoe. Structural scoliosis has not been found in these patients, despite the fact that very few are wearing shoes to correct the pelvic obliquity.

### *Complications*

Complications of consequence developed in two cases following healing of the tuberculous focus in the hip. Case 6 returned to the clinic two years after the hip was healed for treatment of a stiff neck which proved to be caries of the cervical spine. It is not considered probable that the hip acted as a focus for the new infection. This seems to emphasize the necessity for constitutional treatment to securely encapsulate infected bronchial or mesenteric glands.

Case 24 returned to the hospital with a large soft-tissue abscess in the thigh one year and nine months after the hip was thought to be healed. This tuberculous lesion responded so readily to complete excision that it was attributed to a slowly developing focus transplanted during the operation.

### *Elapsed Time Since Arthrodesis*

Eight years have elapsed since the first hip was fused by the pedicle-flap method. Three patients have been under observation seven years, eight for six years, three for five years, five for four years, five for three

years, four for two years, and four for one year or less since the fusion operations were done.

### CONCLUSIONS

This report must be considered in the light of a preliminary study. The number of patients observed is not sufficiently great to warrant positive statements relative to the healing of bone and joint tuberculosis. An additional ten to fifteen years of observation will be essential before it can be definitely recommended that all tuberculous hips in children should be fused in a position of fifteen degrees of flexion and ten degrees of abduction.

It is believed that early fusion of tuberculous joints conserves the growing elements of bone, thereby eliminating the disability due to shortening.

Hibbs's observation, that fusion of the bone flap or strut is followed by consolidation of the diseased area, has been confirmed.

Joint tuberculosis will heal rapidly when motion is eliminated. This may be successfully accomplished by iliofemoroplasty. Draining sinuses are not a contra-indication to iliofemoroplasty. The sinuses will close when the bone and joint lesion is healed. Secondary infection is of no practical importance so far as the operation itself is concerned. The general physical condition of the patient is uniformly good after ankylosis of the diseased joint takes place.

Ilio-femoroplasty is not a difficult technical procedure and it may be done without danger to life.

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# A REPORT OF SEVENTEEN CASES OF TUBERCULOSIS OF THE HIP FUSED BY THE WILSON METHOD

BY LOUIS ALPERT, M.D., MIDDLEBORO, MASSACHUSETTS

*Lakeville State Sanatorium*

After having attempted more than a dozen fusions of tuberculous hips according to the Hibbs method, with rather unsatisfactory results in the majority of cases, a different surgical procedure was desired.

In 1927 Dr. J. C. Wilson suggested an operation for fusing tuberculous hips which he described as an "Ilio-Femoro-Plasty".<sup>1</sup>

In 1930 Dr. Z. B. Adams, our orthopaedic consultant at Lakeville State Sanatorium, adopted this method of fusing tuberculous hip joints. He has modified it, however, by approaching the hip joint through an anterolateral incision and by leaving the entire capsule intact, rather than incising it parallel with the neck of the femur as in Wilson's operation. Thus the operation, as performed at this institution, is a complete extra-articular one and is attended with very little danger of incising a tuberculous focus.

This operation is primarily indicated in children up to twelve years of age, as the bone in children is more flexible and will bend easily, whereas in adults the bone is brittle, and the iliac flap is apt to break off at its attachment as it is bent downward on itself to be inserted into the trochanter. Our youngest patient was four years old and the oldest eighteen.

Up to date this method of fusion has been tried in seventeen cases. We have been able to follow thirteen of them and each one has resulted in a completely ankylosed and painless hip joint. The last four cases have been done very recently and have not yet come out of plaster. These hips have, therefore, not yet been examined for results.

It will be noted from the chart that three of the cases also had other forms of surgical fusion with unsatisfactory results. The Wilson fusion was done after the previously attempted fusion and in all three cases ankylosed hip joints resulted. One death is recorded in this series. This patient died of generalized tuberculosis and at autopsy was found to have extensive processes in the chest, spine, tubes, uterus, and ovaries in addition to her hip and knee involvements. The hip was examined at autopsy, which was eight months after operation, and was found solid with a good, thick bone block. The knee was also solid.

The time required for this operation is about forty-five minutes, and the plaster is applied immediately after the operation, while the patient is coming out of ether; the leg is held in fifteen degrees' abduction and about thirty degrees' flexion. Dr. Wilson found it necessary to place his patients in plaster shells after the operation, thereby lessening the time and avoiding shock from wet casts. We have practically no complications of shock, even with patients who have been confined to bed for two

TABLE I

	NAME	AGE	LESIONS	DURATION OF HIP LESION	OPERATIONS	RESULTS
Case 1	W. S.	8	Tbc. hip, left	4 years	Wilson	Hip solid on discharge (14 months after operation)
Case 2	E. D.	12	Tbc. hip, right	10 years	Arthrodesis before admission Wilson 14 months after admission	13 months later, motion present 16 months after operation, hip solid
Case 3	B. P.	18	Tbc. hip, left	3 years	Hibbs fusion 2 years after admission Wilson 4 years after admission	20 months later, motion present
Case 4	S. G.	11	Tbc. hip, right	16 months	Wilson, Apr. 1931	10 months later, hip solid
Case 5	M. M.	18	Spine, 12D-1L Tbc. hip, right	3 years	Excision of knee joint, Nov. 1928	Hip solid, Aug. 1932 Patient died of generalized tuberculosis
Case 6	F. F.	18	Tbc. knee, right Tbc. hip, right	5 years	Wilson, Apr. 1931 Hibbs, Feb. 1930 Wilson, Nov. 1931	At autopsy hip was solid Motion present Hip solid, Aug. 1932
Case 7	E. C.	8	Potts' disease Ilium and abdominal tuberculosis Tbc. hip, left	Since 20 months of age	Wilson, June 1931 Albee spinal graft, Apr. 1932	Hip solid, Aug. 1932
Case 8	A. B.	4	Tbc. hip, left	1 year	Wilson, May 1931	Hip solid, Aug. 1932
Case 9	A. S.	7	Tbc. hip, left ilium	2½ years	Wilson, Sept. 1931	Hip solid, Aug. 1932
Case 10	T. M.	6	Tbc. hip, left	2 years, 10 months	Wilson, Nov. 1931	Hip solid, Aug. 1932
Case 11	B. S.	10	Potts' disease Tbc. ulna, right Tbc. hip, right	1½ years	Sauzeurization of ulna, Nov. 1931	Ulna healed
Case 12	G. T.	10	Tbc. knee, left Tbc. hip, left	Since 2 years old	Wilson, Nov. 1931 Wilson, Nov. 1931	Hip solid Hip solid, Aug. 1932
Case 13	A. B.	14	Tbc. hip, left	2 years	Wilson, Jan. 1932	Hip solid, Aug. 1932
Case 14	N. J.	7	Tbc. hip, right	4 years	Wilson, Apr. 1932	Still in plaster
Case 15	M. Z.	7	Tbc. spine Tbc. hip, left	4 years	Wilson, May 1932	Still in plaster
Case 16	W. W.	6	Tbc. hip, right	3 months	Wilson, June 1932	Still in plaster
Case 17	T. D.	7	Tbc. hip, right	2 years	Wilson, July 1932	Still in plaster

NOTE: Since this paper was submitted for publication, Cases 14 and 15 have been examined and the hips were found to be solid.

years or more. Our rule is to allow the patient up and about on crutches for at least two months previous to operation. We also avoid operating in the presence of sinuses. After operation the patient is kept in bed for four to six months with plaster fixation and is then allowed up in a single short spica and allowed to bear weight.

#### SUMMARY

1. Seventeen cases of tuberculous hips have been fused by a modified extra-articular and extracapsular iliofemoroplasty, as first described by Dr. J. C. Wilson.

2. Complete ankylosis was obtained in all of the thirteen completed cases.

3. The advantages of this type of fusion are that the operation takes less time; it does not enter the tuberculous joint, and it gives very satisfactory results. We have had no postoperative sinuses, no complications, and no failures.

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# COMBINED INTRA-ARTICULAR AND EXTRA-ARTICULAR ARTHRODESIS FOR TUBERCULOSIS OF THE HIP JOINT \*

BY MELVIN S. HENDERSON, M.D., ROCHESTER, MINNESOTA

*Section on Orthopaedic Surgery, The Mayo Clinic*

The thirty-seven cases which form the basis of this report are presented as evidence that fusion of the hip joint by arthrodesis for tuberculosis deserves the general recognition it has received. I shall compare as fairly as can be done in a limited series the intra-articular type of operation, the extra-articular type, using some form of bone grafting, and what might be called a combined operation in the course of which thorough removal of tuberculous tissue is done and in addition a bone graft is used. These patients were taken care of in The Mayo Clinic between 1919 and 1931 inclusive. I do not intend to review the literature on tuberculosis of the hip, although I am well aware of the large amount available, but reports of operative end results, comparisons of methods, and considerations of operative complications are not common.

## SUMMARY OF CASES

Twenty-one (56.7 per cent.) of the patients were males and sixteen (43.3 per cent.) were females; the right hip of twenty (54 per cent.) was involved and the left hip of seventeen (46 per cent.). The ages ranged from nine to forty-eight years. There were two patients in the first decade of life, twelve in the second, fifteen in the third, four in the fourth, and four in the fifth; twenty-seven (73 per cent.) were between the ages of ten and thirty years.

The symptoms had existed from five months to forty years. In four cases symptoms had been present for less than one year, in nine for two to five years, in seven for six to ten years, in ten for eleven to twenty years, in four from twenty-one to thirty years, and in three from thirty-one to forty years. A definite familial history of tuberculosis was obtained in seven (19 per cent.) of the cases.

Trauma seemed to be reasonably under suspicion as a factor in fourteen cases (38 per cent.); this is rather a high figure, although the period of time between the sustaining of the trauma and the definite development of the disease ranged from a few days to a year. However, the personal equation must necessarily enter into this phase of the subject.

In five cases (13.5 per cent.) there was a history of contact of the patient in a fairly intimate way with some others who had open pulmonary tuberculosis.

Operation was performed on thirty-four patients (92 per cent.) in the chronic stage of the disease; on one patient (3 per cent.) in the subacute

\* Read before the American Orthopaedic Association, Toronto, Ontario, June 16, 1932.



stage and on two patients (5 per cent.) in the acute stage. The joint fused satisfactorily in the patients in the acute stage,—one in three months without drainage, and the other in eight months with drainage for the same period.

It seemed to me that the treatment previous to operation had been sufficiently adequate and good in eleven cases (30 per cent.), and the condition of the patient at the time of operation could not fairly be attributed to neglect or improper treatment. In twenty-six cases (70 per cent.), however, the conservative treatment accorded could not be considered at all satisfactory.

The general condition of the patients at the time of operation was good in twenty-one cases (56 per cent.), fair in fifteen (40.5 per cent.), and poor in one case. Tuberculosis elsewhere than in the hip joint was found in nine cases (24 per cent.). In six cases the lungs were involved, in two the spinal column, and in one case the spinal column and testis were involved. These conditions, however, were sufficiently quiescent to permit operation on the hip and in none caused any concern after the operation.

In all cases the patients complained of pain; the limb was shortened by an average of four and seven-tenths centimeters. In six cases there were healed scars of previously draining sinuses. Draining sinuses should be considered a contra-indication to arthrodesis; such sinuses were not present in any of our cases. Deformity caused by flexion and adduction was present in more than half the cases, but no appreciable deformity was present in seven. Atrophy of the thigh was present in all. The common change noted in the roentgenograms was atrophy of the bone, and in ninety-one per cent. the destructive changes were in the head of the femur and acetabulum. In two cases there were changes in the head and neck of the femur only, and in one case in the acetabulum only.

Definite information concerning the end result in thirty-six cases has been received. In the single case classified as undetermined with regard to result, the patient was dismissed in good condition, still wearing a cast at the end of three months, but has not been heard from. Another patient, a boy, aged thirteen years, in progressively poor general condition at the time of operation, although organic disease or tuberculosis was not demonstrable elsewhere, died of generalized miliary tuberculosis seventy days after an extra-articular operation to effect fusion by bone graft. Thus we have thirty-five patients concerning whom we have enough definite data to base an opinion as to the result of the particular type of operation performed.

At the time of operation, tissue from nineteen of the thirty-seven patients was submitted to the pathologist for microscopic examination. The condition in thirteen cases was reported positively as tuberculous, but in six, inflammatory changes only were distinguished histologically. In all, however, the clinical diagnosis was, without equivocation, tuberculosis, and the destructive process causing disintegration of the structures

of the joint was so evident at operation that the surgeon did not feel the necessity of pathological corroboration of the diagnosis and proceeded without delay with the arthrodesis. In three cases inoculations of guinea pigs were resorted to, and in all reactions were positive. In one of these cases at the time of operation histological examination of the tissue had disclosed only inflammatory changes. Therefore, in the series there are fifteen cases (40 per cent.) of tuberculosis, definitely proved by microscopic examination of the tissue removed, by inoculation of guinea pigs, or by both. The remaining twenty-two cases have been carefully selected because of the clinical history, the observations on physical examination, and the pathological changes seen at the time of operation, all pointing directly to tuberculosis as the cause of the destructive arthritis.

#### TYPES OF OPERATION AND END RESULTS IN THIRTY-FIVE CASES

Formerly, there were so many failures following the ordinary attempts at intra-articular arthrodesis that the operation fell into disrepute. When the various extra-articular operations were advanced, and advocated in this country particularly by Albee and Hibbs, action was stimulated once more. Since fusion has been almost uniformly satisfactory in arthrodesis of the knee joint for tuberculosis, when all the tuberculous débris can be removed, it seems reasonable to assume that the same complete operation in the hip joint would give equally good results provided such a radical operation was not too severe, and that subsequent drainage due to involvement of the soft tissues by tuberculosis would not be too prolonged and profuse. It must be remembered that a complete and adequate extra-articular operation is not the simple mechanical procedure it might seem, that comparatively few surgeons have the skill to carry it out properly, and that not all cases are suitable for this operation. It would appear to be a more rational procedure to attack the affected part and remove the tuberculous tissue, than merely to give support and wait for nature to overcome slowly the tuberculosis within the joint and contiguous bony structures. If this operation can be done with no more risk to life, with no more frequent and prolonged drainage, and if failures are less common, then, other things being equal, the more radical operation, with removal of the affected tissue, is indicated, particularly since operation must be performed in either case.

I have used a varied type of incision, but in the main have employed the Smith-Petersen type. I have changed part of his cutaneous incision by making a long curved incision, so that the base of the resulting flap will be upward; the incision extends from several inches behind the anterior superior spine of the ilium, sweeping downward posteriorly, and toward the greater trochanter, thence curving downward and forward to several inches below the greater trochanter. This flap of skin is then dissected upward, and fastened by skin clips to the wall of the abdomen and anterior portion of the thigh, thus keeping the skin of the groin, so

difficult to cleanse, out of the operative field. The gluteal muscles are then reflected from the wall of the ilium, and the capsule of the joint is exposed. In all cases the capsule, unless already destroyed, was found to be oedematous and greatly thickened. At this point the decision must be made as to whether the operation is primarily to be extra-articular, or if the operative attack should be carried directly to the cavity of the joint itself. Bone abscesses either in the femoral head or in the acetabulum were observed in fifty-seven per cent. of the cases in which the joint was opened and the radical operation performed.

I obtain bone for a graft from the ilium, place it so that it bridges from the ilium to the greater trochanter, and wedge it in tightly, with the hip held at the elective angle at which it is to be placed in the cast. The anterior superior spine has been used as a graft in three cases after the method suggested by Ghormley. The criticism leveled at the intra-articular operation, by which the joint is radically opened, the acetabulum cleaned out, and the head of the femur freshened to secure good contact of bony surfaces, that it is more prone to cause dissemination of the tuberculosis, is I believe, not founded on facts supported by a sufficient number of cases to be acceptable. On the contrary, the present series of cases seems to refute any such charge. The various types of arthrodesis, which were considered last year before this society by Ghormley, in the main are all devised with the desire to avoid extensive exposure of the hip joint itself, aiming to obtain fusion by the aid of extra-articular bone grafts.

In the thirty-seven cases there were no postoperative infections in the ordinary sense, and no operative deaths; the only death that occurred was that of a boy, seventy days after operation, due to dissemination of infection to the lungs, and to other organs. The operation was extra-articular in type.

*Intra-Articular Operation Without Bone Graft.*—In only two cases was the intra-articular type of operation alone used. In one the operation was incomplete, the head not being thrown out of the acetabulum and freshened, and failure resulted. In the second case all of the affected tissue was thoroughly and completely dissected away, a number of bone abscesses were cleaned out, and the bony surfaces of the head of the femur and of the acetabulum were freshened. Union, with excellent function, resulted. There was no postoperative drainage in either case.

*Combined Intra-Articular and Extra-Articular Operation With Bone Graft.*—Wide exposure of the joint was made, the head of the femur was dislocated and the bony contour of the acetabulum and femoral head were thoroughly cleansed and freshened so as to expose plenty of healthy, fresh bone on each articular surface. Even at the expense of prolonging the operation a diligent attempt was made to remove as much as possible of the diseased tissue and tuberculous débris. In the more recent cases I am confident that the development of bony fusion has been hastened not only by thoroughly removing the cartilage from the bone on both

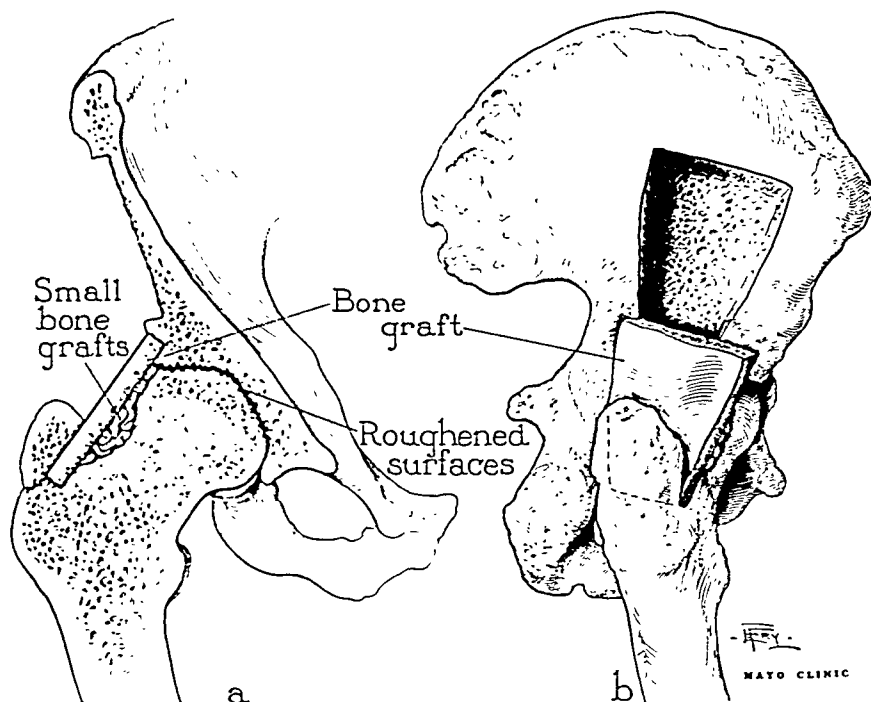


FIG. 1

a, Sagittal view of joint. b, Lateral view of graft.

femoral head and acetabulum, but by using a small gouge to dig up little pieces of spongy bone on both the femoral head and acetabulum (Fig. 1). When this is thoroughly done and the surfaces are shaped to fit, these little, partially detached balls of spongy bone will mesh. In addition, a bone graft obtained from the wall of the ilium is carefully wedged into the split trochanter and into the iliac wall, and beneath it, between the freshened femoral head and neck, are packed numerous small grafts of spongy bone obtained from the raw place on the ilium left by removal of the graft. These steps completed, the leg is carefully held at the angle of election, and the gluteal muscles are sewed back to the crest of the ilium just as a trap door would be closed. Nineteen patients were operated on by this method. One patient was lost track of three months after operation, and the end result is not known, leaving eighteen known results. Seventeen (94.4 per cent.) patients are known to have fused hips, with bony ankylosis and good function. Of sixteen patients, the operative notes stated that twelve joints were dry and four were wet. Of the nineteen patients, five (26.3 per cent.) had drainage postoperatively for from three to eighteen months; in one case, in which operation was done three years ago, the joint is still draining and without union. In fourteen (73.7 per cent.) the wound healed by primary intention without subsequent drainage.

Eikenbary and LeCocq<sup>1</sup> in 1929 reported a series of cases in which

an operation similar to that here described had been used with satisfactory results.

*Extra-Articular Operation With Bone Graft.*—In sixteen cases fusion was attempted by extra-articular methods. In some, the capsule of the joint was opened as in the so-called para-articular operations, in which the top part of the capsule is opened to permit access to the neck of the femur, whereas in others tuberculous pus and débris were present in soft-tissue abscesses, so that there was contact with the tuberculous material. As stated, one patient died, leaving fifteen by whom to estimate results. In two cases second operations were necessary; that is, there were seventeen operations on fifteen patients with fourteen successful, a percentage of eighty-two and three-tenths successful operations. If the two extra operations are disregarded and only the ultimate result is estimated, fusion was obtained in fourteen (93.3 per cent.). Drainage occurred in six instances, and lasted from three to twenty-four months.

#### COMMENT

Taking the group as a whole, thirty-two of thirty-five patients (91.4 per cent.) obtained bony ankylosis. However, if we count the two extra operations in the extra-articular group against the number of cases, the percentage would be eighty-six and five-tenths. The average length of time before union was secured ranged from three months to two years, with an average of eight and eight-tenths months. In more than seventy per cent. of the cases, healing was by first intention. In eleven cases sinuses developed and drained. This was doubtless due to dissemination of the tuberculosis. These sinuses always become infected with the ordinary pyogenic bacteria, but they do no appreciable harm, and healing occurs when the tuberculosis is overcome. In one case, in a woman of the pale, blond, thin-skinned type, with semiblue sclera, and with a familial history, an ugly breaking-down of the whole superficial wound in the heavy pad of fat over the trochanteric area occurred, and the wound drained for eighteen months, but excellent bony union resulted.

#### SUMMARY

Study of the end results in thirty-five cases discloses that bony fusion was secured in thirty-two (91.4 per cent.). The fact that there were no operative deaths indicates that among patients who are in good or fair general condition, a carefully conducted operation to produce arthrodesis in the hip should be advised without hesitation. From such a small series an opinion cannot be expressed as to its value for children, for there were only two patients in the first decade of life; union resulted in both cases, however. Although postoperative drainage due to dissemination of the tuberculosis to the contiguous soft parts is not a comfortable situation, and occurred in eleven of the cases, it was not as serious as might appear. Drainage followed in forty-four per cent. of cases in which there were "wet" joints and in twenty-two per cent. in

which there were "dry" joints. It occurred in a higher percentage of cases when the operation was extra-articular than it did when the combined operation was employed. I interpret this to mean that the occurrence of drainage is less if the tuberculous tissue is cleanly removed, to the best of the surgeon's ability. A purely extra-articular operation is occasionally possible, but often tuberculous tissue is encountered. The percentage of "wet" joints in the combined intra-articular and extra-articular group and in the extra-articular group was the same.

The great improvement in the general health in these patients following arthrodesis has been most striking. A stiff hip has not been an added handicap, for the hip was not only stiff before operation but was painful. More uniformly successful results have been obtained by the combined method of intra-articular and extra-articular operation together with bone graft than by any other method.

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## THE TREATMENT OF OSTEOMYELITIS BY BACTERIOPHAGE \*

BY FRED H. ALBEE, M.D., SC.D., LL.D., F.A.C.S., NEW YORK, N. Y.

*Professor of Orthopaedic Surgery, Post-Graduate Medical School, Columbia University*

One of the most difficult problems confronting the modern surgeon is that of dealing effectively—and finally—with his old enemy, latent infection. For centuries men have sought an ideal treatment for infected wounds. We hear of boiling oil, incinerated toads, ashes, and natural balsams, and even sprayed perfumes and soft music. The late War made popular the Carrel-Dakin irrigations and bipp treatments. Following the War maggots came into vogue. In view of this long-continued search, it seems scarcely possible that a method of wound treatment, which may completely revolutionize all our previous concepts could be devised; yet I believe the bacteriophage to be just such a method.

Osteomyelitis is one of the most common forms of bone infection encountered by the surgeon today. Nearly everyone is familiar with the treatment of this condition proposed by Dr. H. Winnett Orr in 1923. Apparently violating the traditions of free drainage, he packed the saucerized wound with vaselin and vaselin gauze and enclosed it in a plaster cast which was left undisturbed for weeks. Soon after operation the patient's temperature dropped to normal and, upon removal of the cast, the wound was found to be covered with healthy red granulation tissue. Orr explained this startling result on the basis of rest, immobilization, and avoidance of reinfection by repeated dressings.

However, this explanation did not seem to me to entirely account for the marked success of the treatment. After close observation of several cases, I became convinced that some unusual phenomenon was taking place. D'Herelle, the Yale bacteriologist, had in 1921 discovered an ultra-microscopic parasite which appeared spontaneously in a culture of dysentery bacilli and destroyed them, thus in many instances saving the patient's life. This he called the "bacteriophage" because it lived on virulent pathogenic bacteria and completely lysed them.

In the mass of detailed bacteriological findings which d'Herelle presented, two experiments struck me as having a definite similarity to what had happened in the Orr-treated wound, and to offer a possible explanation.

In one of his earliest experiments with dysentery bacilli he added about 0.0001 cubic centimeters of bacterial culture to a young broth culture and subcultured the mixture immediately to an agar slant. Ultimately the surface of the agar was well covered with a roughened layer of the multiplying bacteria. Then, after a *long period of time*, two little islands appeared, two clear plaques perfectly circular in form where the

\* Read at the Annual Meeting of the American Orthopaedic Association at Toronto, June 17, 1932. Submitted for publication July 14, 1932.

agar was bare, entirely free of all traces of the bacterial colony. D'Herelle explained this striking phenomenon by the spontaneous appearance of a bacteriophage which absolutely destroyed the bacteria with which it came in contact.

To prove this, his next step was to apply a platinum loop to the roughened surface of the agar and transfer a bit of the bacterial colony to a test tube of clear bouillon and incubate it. Within a short time, the tube was so teeming with bacteria that it was turbid and opaque. D'Herelle then transferred to this turbid culture an infinitesimal portion of one of the clear plaques on the agar slant. After a few hours, the bouillon, as if by magic, became perfectly clear and transparent, and centrifuging of the culture failed to disclose any bacteria whatsoever. Not only had all bacteria been killed, but their bodies had been lysed or dissolved.

Now if a chemical germicide had been placed in this tube or heat applied, the bacteria would have been killed, but at the bottom of the tube there would have been the dead bacterial bodies. Not so in this tube of d'Herelle's. There was not a trace of sediment. Not a dead bacterial body could be found.

Having observed this remarkable phenomenon in tube No. 1, d'Herelle took a second tube and repeated the process, except that he introduced the phage from tube No. 1 instead of from the agar slant. The result was the same—complete lysis of the bacterial bodies—showing that the phage had not lost its potency through lysing the bacteria in tube No. 1. He then took a third, fourth, fifth, and even twentieth tube, in each instance transferring a bit of bacterial colony from the agar slant and incubating it; then, when the tube was turbid with bacteria, dipping a platinum loop into the preceding tube and transferring a tiny portion of the fluid to the last tube. Each time there was the same evidence of the activity of the bacteria-destroying phage, striking proof that he was dealing with a living organism, capable of self-reproduction; for an enzyme or any non-multiplying agent would have lost its potency from extreme dilution long before it reached the twentieth tube.

D'Herelle further demonstrated by laboratory experiment that there were several varieties or "races" of phage, for the various strains of each type of bacteria, but that these also had certain destructive influences upon other strains of bacteria.

The analogy to the bacteriophage-treated wound is obvious. When one closes up the wound with a paraffin-vaselin tampon and plaster cast, it is infected and discharging pus. When one removes the dressing eight weeks later, the wound is clean and healthy. Whatever agent clears out the offending infection appears spontaneously, as on d'Herelle's slant culture, for none has been introduced. And the long lapse of time, just as in his experiment, permits this agent to carry on its bacteria-destroying action to a successful end. Is it not logical to assume that the phage principle has been working in the wound, that a native bacteriophage has multiplied and become active under the long-continued dressing?



With this working hypothesis, I immediately proceeded to use this revolutionary method in all cases of osteomyelitis, and by careful laboratory search and clinical tests, it was established that, as I had assumed, a specific phage did appear spontaneously in about ninety-four per cent. of cases of acute and chronic osteomyelitis.\* In three of the remaining six per cent. in which the phage did not appear spontaneously, the laboratory has been able to supply us with a phage specific for the organism in question; but in the other three per cent. it has, so far, been unable to do so. This is especially true of the streptococcus hemolyticus, and in these cases, we have adopted a policy of watchful waiting. In several instances, the desired phage has later appeared in the wound spontaneously and healing has occurred. It is hoped that with the perfection of laboratory methods and increased knowledge of the phage, it may be possible to isolate races of phage specific for each strain of bacteria in all cases.

In cases of osteomyelitis, both acute and chronic, I now make use of the following method of treatment. I do not use alcohol or iodine as does Orr, lest they interfere either with the development of the spontaneous phage or with the specific laboratory-bred phage after its introduction.

In precisely the same way the chemical spray does more damage to the beneficial parasite than to the pathogenic pest in the orange or grapefruit groves, and therefore should not be used. One of the orchard grower's problems is how to destroy the purple scale, which kills orange trees just as bacteria kill human tissues. There are open to him two methods of combat,—he may spray his trees with a strong chemical which parallels the Carrel-Dakin treatment; or he may let a parasite fight the battle instead. This is the red-headed ray fungus, a parasite which exists in orange groves by eating the purple scale. The threads of the fungus penetrate the body of the scale and eventually kill it as well as the eggs it contains. If the fungus does not of itself arrive in the grove, the gardener may import it. For certain other pests, he may introduce lady beetles if they do not spontaneously appear, as they often do. Fruit growers now seldom spray trees with chemicals to destroy certain pests, if they can make use of a living parasite or natural enemy, for the latter method is much more reliable. In fact, some pests are completely resistant to chemical sprays and can only be eradicated by a natural enemy or parasite (phage).

The treatment of a group of cases of osteomyelitis with complications, such as infected fractures, entails a multitude of considerations. In most of these cases, we have deep wounds extending into the bone, with varying degrees of infection. The ideal wound dressing must, therefore, have a degree of solidity sufficient to restrict the tendency of the orifice at the dermis to close earlier than the depths of the wound. At the same time, this tampon should be such that it can be inserted in practically a fluid state, in order to flow uninterruptedly to every recess of the wound; it

\* I am indebted to Dr. Ward MacNeal and Miss Marjorie Patterson of Post-Graduate Hospital for extensive help in this work.

should then become semi-solid, thus tending to conserve the original contour of the wound, avoid adherence to the bone, and, bit by bit, extrude automatically as granulations fill up the depths of the wound, or as the contractions of healing and cicatrization demand.

If the consistency of the tampon can be altered by changing the relative amounts of the ingredients composing it, too early extrusion can be avoided in wounds of great depth, and, conversely, rapid extrusion can be favored in shallow wounds where earlier closure is desirable and possible. With these requirements in mind, I am now using, instead of the vaselin and vaselin gauze applied in earlier cases, different mixtures of paraffin and yellow vaselin, the proportions depending on the nature of the wound. In deep wounds, paraffin and vaselin are used in a strength of ten to one; in suppurative wounds, where early closure is desired, the mixture is four parts of paraffin to one part of vaselin. The mixture is always put into the wound in a melted state, at about 110 degrees, fahrenheit, this being accomplished by immersing the jar containing the mixture in a water bath for some time before the mixture is used. It is then inserted into the wound by means of a large syringe.

I do not favor the vaselin, vaselin-gauze dressing for several reasons:

a. It is impossible to satisfactorily control the consistency of the vaselin, vaselin-gauze tampon. Due to the ingredients comprising it, this tampon cannot, at best, be uniform in its consistency.

b. Later experience has shown that, even when an excess of vaselin is added with the vaselin gauze, the gauze is still apt to become adherent to the bone at the bottom of the wound and so resist extrusion of the tampon and delay healing.

c. The wound granulations are likely to strangulate through the meshes of the gauze.

None of these complications ever arises with the paraffin and vaselin dressing, which, because of its proper degree of solidity for the particular case, the uniformity of its consistency, and its slippery surface, will always extrude much more satisfactorily than the vaselin, vaselin-gauze dressing, acting in a manner apparently somewhat similar to the bipp tampon. Furthermore, it has been found that the bacteriophage occurs spontaneously just as frequently as with the gauze dressing; also, the laboratory-bred phage, when introduced, acts as favorably. I have been unable to find any shortcomings of this dressing as compared with either the bipp or the vaselin, vaselin-gauze dressing. Bipp, however, may be contra-indicated because of the possible unfavorable chemical action of the iodoform upon the bacteriophage.

*Technique.* The usual sequestrectomy and saucerization are completed, and a culture is taken. (If a specific phage has already been found from a culture previously taken from an existing sinus, two-thirds of a test tube of this phage is poured into and over the wound, so that the whole surface is bathed.) The wound is then packed with a paraffin and vaselin mixture, usually seventy-five per cent. paraffin to twenty-five per cent.

vaselin; or, in cases where the wound is deep and made through heavy muscles, ninety per cent. paraffin to ten per cent. vasetin. No vasetin gauze whatsoever is used. The paraffin and vasetin are heated and poured in as a liquid, or forced in by pressure through a large syringe. In most cases, the syringe is the method of choice, in order to insure penetration of the mixture to the innermost recesses of the wound.

One end of a rubber catheter is inserted through the paraffin-vaselin wound tampon to the bottom of the bone cavity. The other is allowed to project through the dressings and cast (which are applied as usual), with a sterile gauze or cotton over the end. If the laboratory examination of the culture reveals that it is possible to develop a bacteriophage specific for the organism presented, ten cubic centimeters of this phage are injected through the rubber catheter once or twice a week. Care should be taken when making periodic injections not to infect or contaminate the end of the tube. Should the bacteriophage appear spontaneously in the wound, injection of the laboratory-bred phage is still of advantage in that it accentuates the action of the native phage, and may be a more specific one. This practice is of still further advantage because, if an original phage does not completely destroy a culture, the organisms that survive give rise to a resistant strain which may be pathogenic for its host but is affected by the old bacteriophage. In large wounds, several catheters may be inserted, some of which are multifenestrated. Inasmuch as the catheter is firmly imbedded in the paraffin-vaselin tampon, the injected phage fluid cannot flow backward between the catheter and the tampon. It must, therefore, make its way *inward* between the tampon and the wound granulations, and thus, by reason of its own bulk, spread widely. Furthermore, since the phage is, by nature, a multiplying organism, it will thus automatically spread over the wound surface.

TABLE I

## RESULTS OF TREATMENT\*

Average Healing Time.....	6 months
Average Number of Cast Dressings.....	3
Average Number of Weekly Dressings.....	3
(to complete skin healing)	
Appearance of Bacteriophage:	
Spontaneous.....	94 per cent.
Introduced.....	6 per cent.
Type of Infecting Organism:	
Staphylococcus.....	40 per cent.
Streptococcus.....	15 per cent.
Mixed:	
Staphylococcus Predominating.....	38 per cent.
Streptococcus Predominating.....	15 per cent.
Tuberculosis.....	2 per cent.
Bacillus Welchii (present with other organisms).....	7 per cent.
Flora Changed During Treatment.....	22 per cent.
(usually to a more favorable type of organism, resulting in rapid healing.)	

\* Based on a series of 100 consecutive cases.

At the end of eight weeks the cast is removed and the wound dressed, great care being taken not to traumatize the granulating surfaces. The discharge around the edges of the wound is wiped off very gently with sterile gauze and the skin cleansed with benzin.

If the wound is not entirely healed when the cast is removed, it is again bathed with a test tube of the prepared specific phage fluid and a catheter or catheters inserted to the depths of the wound. A paraffin-vaselin tampon is used as before and a cast applied for an eight-week period. A culture is also taken at this time to determine whether the bacterial flora of the wound has changed, and also whether a more specific race of phage can be obtained. Periodic injections through the catheter are given as before.

I have recently completed a statistical study of 100 consecutive cases treated by this method which shows that the average healing time for a case of osteomyelitis so treated is about six months. Three casts are applied at intervals of eight weeks, and, after removal of the third, weekly dry dressings are done until skin healing takes place. The type of infecting organism varies,—staphylococcus, or a mixed infection with staphylococcus predominating, being the most frequent. It is interesting to note that the bacillus welchii appeared in seven of the series of 100 cases. However, the rod was extremely weak and attenuated and did not interfere in any way with the healing of the wound. The flora changed in twenty-two per cent. of the cases, usually to a more favorable type of organism, resulting in rapid healing.

Those cases in which a native phage develops usually do very well without the insertion of a laboratory-bred phage. However, in view of our latest investigations, we feel it is wise to inject periodically a race of phage of the highest potency, in order to have at work for a maximum period of time a phage of the highest specificity. In this way, any possible decrease in potency of the native phage is offset.

We have done extensive research to determine the relative effectiveness of plain and irradiated vaselin, and have established that there is no difference in their effect upon either bacterial cultures or different races of the bacteriophage. A résumé of the experiments follows:—

<i>September 7, 1931.</i>	}	Staphylococcus broth cultures placed in contact with irradiated vaselin on petri dishes; cultured every three days for four weeks; all cultures grew in twenty-four hours.
<i>September 17, 1931.</i>		
<i>October 19, 1931.</i>	}	Staphylococcus broth cultures placed in contact with plain vaselin on petri dishes; cultured every three days for four weeks; all cultures grew in twenty-four hours.
<i>October 22, 1931.</i>		

*December 3, 1931.* Four staphylococcus plates sealed with irradiated vaselin on opposite sides of petri dish (air space between culture and vaselin); cultured every week until March 3, 1932; all cultures grew in twenty-four hours.

*February 27, 1932.* Staphylococcus broth culture in contact with irradiated vaselin in petri dish; cultured every week until April 11, 1932; all cultures grew in twenty-four hours.

*February 27, 1932.* *Bacillus coli* broth culture in contact with irradiated vaselin in petri dish; cultured every week until April 11, 1932; all cultures grew in twenty-four hours.

*February 27, 1932.* *Streptococcus hemolyticus* broth culture in contact with irradiated vaselin in petri dish; cultured every week until April 11, 1932; all cultures grew in twenty-four hours.

*February 27, 1932.* *Staphylococcus* broth culture in contact with plain vaselin in petri dish; cultured every week until April 11, 1932; all cultures grew in twenty-four hours.

*February 27, 1932.* *Bacillus coli* broth culture in contact with plain vaselin in petri dish; cultured every week until April 11, 1932; all cultures grew in twenty-four hours.

*February 27, 1932.* *Streptococcus hemolyticus* broth culture in contact with plain vaselin in petri dish; cultured every week until April 11, 1932; all cultures grew in twenty-four hours.

<p><i>September 7, 1931.</i> <i>September 17, 1931.</i> <i>October 19, 1931.</i> <i>October 22, 1931.</i></p>	}	<p>Bacteriophage culture placed in contact with irradiated vaselin on petri dishes; tested every three days for four weeks for ability to lyse susceptible staphylococcus cultures; all bacteria completely destroyed in twenty-four hours.</p> <p>Bacteriophage broth cultures placed in contact with plain vaselin on petri dishes; tested every three days for four weeks for ability to lyse susceptible staphylococcus cultures; all bacteria completely destroyed in twenty-four hours.</p>
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*February 27, 1932.* Bacteriophage broth solution put into well in large tube of irradiated vaselin; tested for ability to lyse staphylococcus culture every week until April 11, 1932; culture of staphylococcus completely destroyed in twenty-four hours.

*February 27, 1932.* Bacteriophage solution put into well in large tube of sterile vaselin; tested for ability to lyse staphylococcus culture every week until April 11, 1932; culture of staphylococcus completely destroyed in twenty-four hours.

*April 11, 1932.* Irradiated vaselin in contact with photographic film for forty-eight hours; did not fog the film.

*Conclusion:* No difference was noted in the effect of the irradiated and that of the plain vaselin upon the bacterial cultures and the bacteriophage.

My experience with this new method for treating osteomyelitis has convinced me that it is far superior to any other method I have used, and this conviction is borne out by the statistical study which shows the time of healing materially reduced. A summary of the advantages of the dressing follows:—

1. It is simple in its application, requiring a minimum amount of labor on the part of the surgeon and his staff.

2. It does not interfere with the immobilization of the part (as, for example, in the case of a compound infected fracture or suppurating joint), nor does it favor oedema of the granulations or the soft structures because of inequality of pressure at or in the immediate neighborhood of the wound, since there is no window in the cast. This is quite contrary to the Carrel-Dakin or maggot method of treatment, both of which must, of

necessity, have a window in the east. I believe that a uniform pressure over the wound and neighboring tissues (such as this method affords) will avoid exuberant granulations and oedema,—an important consideration in the healing of a wound, as is exemplified in the case of varicose ulcers.

3. The paraffin-vaselin tampon automatically yields to the encroachment of granulation, healing, and closure of the wound, thus gradually extruding and keeping up a constant physiological pressure upon the surface of the wound at all times. This is more effective than frequent dressings by the surgeon, and, in addition, avoids the possibility of reinfecting the wound by a foreign flora of bacteria.

4. This dressing is favorable to the appearance of the native bacteriophage and to the periodic introduction of a laboratory-bred phage.

5. It requires a very short period of hospitalization.

In addition to its application to infected bone wounds, the bacteriophage has proved a most efficacious specific agent in combating lesions such as furuncles, boils, carbuncles, and phlegmons. For these conditions it may be applied in two ways:—

1. It may be thoroughly rubbed over the surface of the wound and the lesion covered by sterile pads soaked in bacteriophage; or, if the lesion is of extensive size or depth, it may be dressed with the paraffin and vaselin tampon with a catheter incorporated for periodic introduction of bacteriophage;

2. It may be injected subcutaneously into the soft parts by means of a hypodermic needle about the periphery of the lesion.

In bacteriemia, particularly with staphylococcus aureus, a bacteriophage prepared with asparagin as a medium and injected into the blood stream, has, in the hands of Dr. MacNeal\* reduced the mortality from practically one hundred per cent. to less than fifty per cent., even when there have been two positive blood cultures. Not only is the bacteriophage a successful local therapeutic agent, but it has the added advantage of helping to establish a possible general immunity on the part of the patient. Also the bacteriophage is, to some degree, effective in experimental animals when injected at a site distant from the infected focus.

The invariable excellence of the results of this new method of treatment for infected wounds should make it unquestionably preferred by all those who experience its advantages over former methods. I believe that the bacteriophage will eventually become one of the surgeon's important weapons against infection. Its potency has become so widely recognized that certain governments (India and Brazil) have passed laws that it be kept constantly on hand for use in certain intestinal diseases. My desire is to stimulate the interest of the surgical world in a phase of bacteriology which will have a profound influence on the future treatment of surgical infections.

\* New York Post-Graduate Hospital.

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# THE PRODUCTION OF CHRONIC ARTHRITIS BY THE INJECTION OF WEAK ACIDS, ALKALIES, DISTILLED WATER, AND SALT SOLUTION INTO JOINTS \*†

BY J. ALBERT KEY, M.D., ST. LOUIS, MISSOURI

It has been shown that arthritic-like changes can be produced by injecting a small amount of a strong chemical irritant (tincture of iodine or pure carbolic acid) into a joint (Axhausen<sup>1</sup>, Key<sup>2</sup>, and Burckhardt<sup>3</sup>). Seeliger<sup>4</sup> produced similar changes in the knee joints of rabbits by repeated injections of 1/50 normal HCl into the joint and believed that the acid reaction within the joint was responsible for the arthritis. Häbler<sup>5</sup> repeated Seeliger's experiments and obtained similar results, but he also produced similar arthritic changes in rabbits by repeated injections of distilled water into the knee joints. Häbler concluded that the arthritis was caused by cartilage damage and that the cartilage damage was caused by a change in the osmotic pressure of the fluid in the joint.

In this paper I shall present the results of a series of experiments in which chronic progressive arthritis was produced by the repeated injection of weak acids, weak alkalies, distilled water, or salt solution into the joints of experimental animals.

## MATERIAL AND METHODS

Thirteen normal adult rabbits were used. The animals were anaesthetized with ether. The knees were wet with alcohol and the irritating fluids were injected directly into the knee joints, using a hypodermic syringe with a small (25 gauge) needle. The fluids used were N/50 HCl, N/50 NaOH, distilled water, 0.85 per cent. NaCl and 10 per cent. NaCl. The N/50 acid and alkali were made up in isotonic (0.85 per cent.) sodium chlorid solution. From one to two centimeters of the fluid were injected into each knee joint three times a week and from eight to twenty-eight injections were given as shown in Table I. The animals were sacrificed at intervals of from one to eighty-five days after the last injection. The knee joints were cultured, then examined in the gross, fixed in ten per cent. formalin, sectioned, and stained with hematoxylin and eosin and the sections studied.

## GROSS PATHOLOGY

(1) Joints Injected with N/50 Hydrochloric Acid: There were seven joints in this series. One which received eight injections and was examined ten days after the last injection showed slight thickening of the synovial membrane and fat pads and slight hyperaemia. The second

\* From the Department of Surgery, Washington University School of Medicine, St. Louis.

† Presented at the Annual Meeting of the American Orthopaedic Association, Toronto, June 16, 1932.



TABLE I

	<i>Number of In- jections</i>	<i>Days</i>	Right Knee		Left Knee	
			<i>Material Injected</i>	<i>Arthritis</i>	<i>Material Injected</i>	<i>Arthritis</i>
749-50	8	10	HCl	+	NaOH	+
741-2	10	3	"	++	"	++
776-7	16	1	"	++	"	++
778-9	19	42	"	+++	"	+++
739-40	28	28	"	+++	"	+++
743-4	28	85	"	++++	"	++++
745-6	28	85	"	++++	"	+++
755-6	17	5	H <sub>2</sub> O	++	0.85% NaCl	++
751-2	28	28	"	+++	"	++++
753-4	28	85	"	++	"	++++
759-60	28	28	"	+++	10% NaCl	+
757-8	28	42	"	+++	"	+
780-1	19	85	"	++++	"	+++

Summary of experiments reported in this paper. The + marks indicate the degree of arthritis present in each knee and the number of days indicates the period after the last injection.

received ten injections and was examined three days after the last injection. This joint contained a moderate amount of cloudy fluid and the synovial membrane was markedly thickened and hyperplastic, and was invading the cartilage all around its margins. The third received nineteen injections and was examined forty-two days after the last injection. This joint also contained a moderate amount of cloudy fluid and the synovial membrane was markedly thickened and stained yellowish-brown in color. There was some erosion of the cartilage around its margins and some softening of the cartilage covering of the bearing surfaces of the condyles and femur. The patella was broadened and its surface roughened. At several points on both the femur and the tibia there was moderate thickening of the bone at the borders of the cartilage. The fourth joint received twenty-eight injections and was examined twenty-eight days after the last injection. In this joint there was slight periarticular thickening and the synovial membrane was considerably thickened, hyperplastic, and stained a light yellowish-brown in color. There were some synovial bands and adhesions in the quadriceps pouch and posterior capsule with considerable erosion of the cartilage on the borders of the

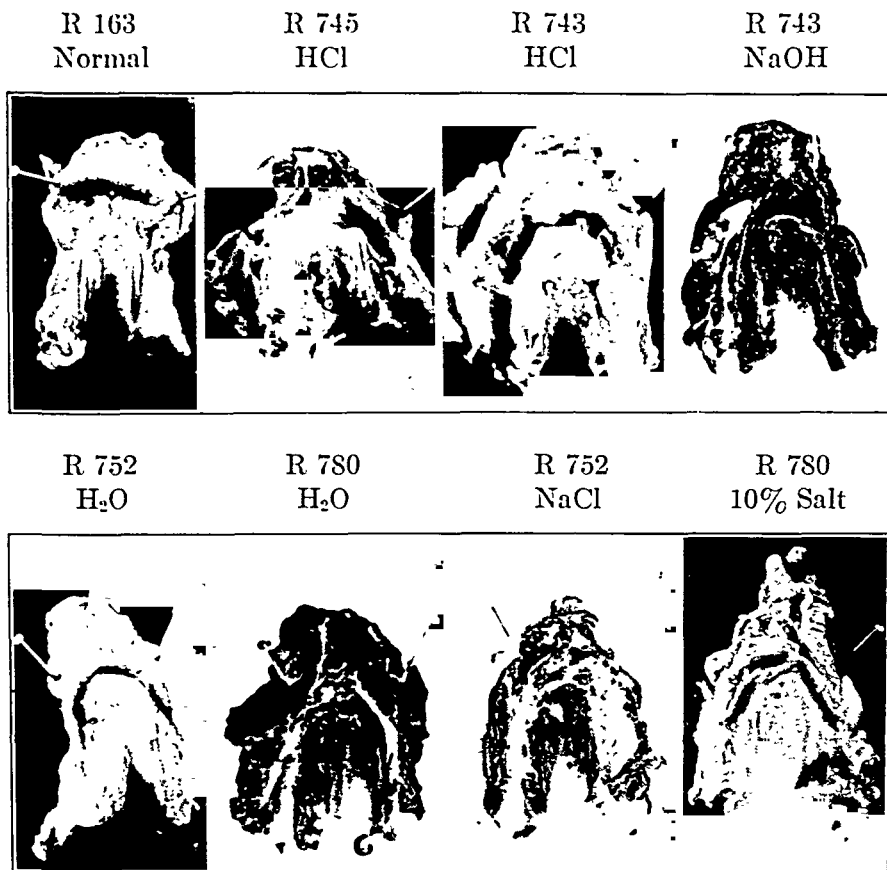


FIG. 1

Gross appearance of chronic arthritis in the knee joints of a series of rabbits induced by repeated injections of mild irritants. Upper left is a normal joint for comparison. Other figures are as marked.

condyles of the femur and on the anterior portion of the tibia. There was some marginal hypertrophy around the borders of the condyles of the tibia and femur.

The other two joints received twenty-eight injections and were examined eighty-five days after the last injection. Both joints contained a slight amount of excess clear fluid and in both the synovial tissues were moderately thickened and hyperplastic and there was softening or erosion of the bearing surfaces of the condyles. In one there was moderate overgrowth of the cartilage at the upper end of the patellar surface of the femur, especially on the internal condyle, and considerable erosion of the cartilage around the posterior borders of the condyles with hypertrophy of the margins of the condyles of the tibia. In the other there was slight marginal hypertrophy around the borders of both bones with a small ulcerated area at the upper end of the internal condylar ridge.

(2) NaOH. This series comprised the left knees of the rabbits in which the right knees received hydrochloric acid. The gross changes in

the sodium hydroxid knees were almost identical with those which had received the acid. There was the same hyperaemia in the earliest joints and the thickening of the synovial tissues and hypertrophy of the fat pads were present in those which had received ten and fifteen injections. Likewise, the hyperplastic synovial tissues exhibited a tendency to invade the margins of the cartilage. In those which had received nineteen to twenty-eight injections there was also considerable marginal hypertrophy of bone and cartilage on both the tibia and the femur, with erosion of the cartilage over the bearing surfaces of the bones, and the changes were of about the same degree as in the corresponding knees of the acid series.

(3)  $H_2O$ . There were six joints in this series. The first one received seventeen injections and in it the synovial membrane was moderately thickened and hyperaemic, while the joint contained a small amount of excess, slightly cloudy fluid. The second joint received nineteen injections. It contained a slight amount of excess fluid, the synovial membrane was moderately thickened and grayish-pink in color and there were numerous coarse bands crossing the joint cavity. There was softening and erosion of the cartilage on the bearing surfaces of the femur and tibia and a punched-out defect on the front of the femur at the upper margin of the patellar surface. There was marked proliferation of the bone and cartilage around both condyles of the femur and around the margin of the internal condyle of the tibia. The other four joints each received twenty-eight injections and were examined in twenty-eight, twenty-eight, forty-two, and eighty-five days.

One twenty-eight-day joint contained a considerable amount of excess clear fluid. The synovial membrane was moderately thickened and stained reddish-brown in color. The cartilage was softened and roughened over the bearing surfaces of the femur and tibia, and there was a small amount of proliferation of the cartilage on the anterior surface of the femur with slight thickening around the margins of the tibia. On the anterior surface of the femur above the cartilage margin there was a definite thickening of the cortical bone. In the other twenty-eight-day joint the changes were similar, except that there was a moderate amount of periarticular thickening and no thickening on the femur above the cartilage. The forty-two-day joint showed marked periarticular thickening with numerous bands in the hyperplastic synovial membrane and relatively little change in the cartilage. In the eighty-five-day joint there was a slight excess of synovial fluid, the synovial membrane was moderately thickened and stained, and there was slight roughening of the bearing surfaces of the femur and tibia with slight invasion of the cartilage, but no definite hypertrophy of the cartilage or bone.

(4) Normal Sodium Chlorid (0.85 per cent. NaCl). There were three joints in this series. The first received seventeen injections and was examined five days later. This joint exhibited moderate thickening and hyperaemia in the synovial membrane and slight hypertrophy of the

internal condylar ridge. The second received twenty-eight injections and was examined twenty-eight days after the last injection. The changes were similar to those which had occurred in the right knee of the same animal which had been injected with distilled water, but were more marked in degree. The synovial membrane was thickened and stained to a variable degree. The softening of the bearing surfaces of the patella, femur, and tibia were more marked and the marginal hypertrophy was greater while there was some definite invasion of the cartilage by the hyperplastic synovial membrane. The third joint received twenty-eight injections and was examined eighty-five days later. In it also the changes were similar to those in the corresponding joint which had been injected with distilled water, but were more marked in degree.

(5) Ten Per Cent. NaCl. There were three joints in this series. The first received twenty-eight injections and was examined twenty-eight days after the last injection. It contained a slight amount of excess fluid, showed slight hyperplasia and staining of the synovial membrane, and the changes were definitely less in degree than in the corresponding joint which had been injected with distilled water. In the second joint which received twenty-eight injections and was examined forty-two days after the last injection, the changes were similar to those in the corresponding joint which had received distilled water, but were much less in degree, and the chief departure from normal was a punched-out defect in the tissue on the front of the femur above the cartilage. This defect extended down to the bone and the base was covered by a very thin, firm, connective-tissue membrane. The third joint received nineteen injections and was examined at the end of eighty-five days. This knee showed no excess fluid. The synovial cavity contained numerous bands and a few small villi and the synovial membrane was rather firm and fibrous in appearance. The fat pad was shrunken and fibrous in character. The tissues above the cartilage on the front of the femur were thin and smooth and atrophic in appearance. There was slight hypertrophy of the upper end of the ridge on the external condyle and a large dome-like exostosis was present on the side of the femur near the lower end of the condyle.

In general the changes in these joints consisted of hyperaemia followed by hyperplasia with formation of synovial bands and villi. The hyperplastic synovial membrane tended to invade the cartilage, and hypertrophy of bone and cartilage occurred around the margins of the cartilage. In all of the joints there was a definite tendency to softening and erosion of the cartilage over the bearing surfaces of the bones. For the most part the semilunar cartilages remained normal, but in a few instances they were roughened. After acid, alkali, or distilled water, the changes were approximately of the same degree in the various joints. After the injection of normal salt solution, the changes were slightly more marked than in the above and in the joints which had received ten per cent. salt solution, the changes were less marked and there was a definite tendency to fibrosis in the synovial membrane.

## MICROSCOPIC CHANGES

HCl. *Synovial Membrane:* The joint which had received sixteen injections of hydrochloric acid, and was examined on the day after the last injection, showed marked thickening of the synovial membrane and infiltration of the synovial tissues with large numbers of leucocytes and small and medium-sized round cells. In the joint examined ten days after the last injection, the leucocytes had disappeared and the infiltration with round cells had increased to a considerable extent. In the early joints the synovial cells were enlarged and increased in number and there was considerable fibroblastic reaction in the sub-synovial tissues with a small amount of villus formation. In the later joints of this series the synovial thickening and infiltration were still present, but were less in degree. In the forty-two-day joints there was a moderate amount of hyaline-like degeneration and many of the cells were vacuolated while the small round cells were arranged in nodules which were often perivascular. In the eighty-five-day joints there was moderate villus formation, but the synovial membrane reaction was considerably decreased, although there still remained a moderate amount of round-cell infiltration in the areolar subsynovial tissues and some small giant cells were present, while in other areas there appeared to be some fibrosis of the surface.

*Cartilage and Bone:* In the joints which had received eight injections, the cartilage surface was intact, but the cells near the surface stained poorly and appeared to be dead, and there were a few empty lacunae in this area. In the joints which had received nineteen injections and were examined forty-two days after the last injection the surface zone of the cartilage was dead, the bearing surface was degenerated and in some places was broken and clefts extended down into the basal zone. In the middle zone the cells for the most part were living and in the basal zone there were many dead cells, some of which were degenerating and forming cysts. Evidence of regeneration in the form of cell nests was present in the middle zone.

In the joint which had received twenty-eight injections and was examined twenty-four days later, most of the cartilage was dead and over the bearing surfaces of the femur it was disintegrating and beginning to separate from the underlying bone. There was no normal structure left, but in the apparently dead matrix in the central areas there were numerous cell nests, some of which were quite large in size, while the marginal areas of the cartilage appeared to be unusually cellular. In some places the subchondral bone appeared to be fragmented and necrotic, and there was definite new bone formation in the subchondral regions and at the lateral borders of the tibia and femur. The fibrous cartilage showed no necrosis.

In the two joints which received twenty-eight injections and were examined eighty-five days later, the bearing surfaces of the joint were completely devoid of cartilage and the exposed bone was necrotic and



FIG. 2

Left: R 778-9: Synovial membrane from chronic arthritis produced by repeated injections of N/50 HCl into the knee joint. Note the mild synovial hyperplasia and subsynovial infiltration with nodules of small round cells.

Right: R 739-40 (HCl) showing hyperplastic synovial tissue overhanging the margin of the cartilage.

eburnated, while the blood vessels near the surface of this bone were thrombosed. In other areas the remaining cartilage was dead and fibrillated and there was some invasion of the underlying bone by cartilage and osteoid tissue. The patellar surface of the femur was covered by a thin layer of necrotic cartilage from which the cells had almost entirely disappeared. A few cell nests were present in the apparently necrotic matrix. There was definite osteophyte formation at the cartilage margins.

NaOH: In the joints which received repeated injections of NaOH, the changes in the synovial membrane were practically identical with those present in the joints which had received acid, except that in the early joints many of the synovial cells were shrunken rather than swollen. As in the acid joints this acute damage to the surface was followed by a stage of synovial hyperplasia and villus formation with infiltration of the subsynovial tissues with small and medium-sized round cells. In the alkali joints macrophages engorged with pigment were seen more frequently than in the acid joints and there seemed to be a slightly greater tendency to fibrosis of the subsynovial tissues. Also the fibrous areas of the synovial surface which were very little affected in the acid joints showed some surface necrosis and degeneration in the alkali joints.

The cartilage in the alkali joints was damaged in the same way as in the acid joints, except that the death of the cells near the surface occurred earlier and was slightly greater in extent. This surface necrosis was accompanied by evidence of hyperplasia in the form of cell nests in the deeper layers and in the joints which had received more injections there was marked degeneration, fibrillation, and erosion of the cartilage, with exposure and eburnation of the underlying bone, and some new bone formation at the margins of the condyles and on the sides of the femur. In some places the cartilage had separated from the calcified zone. As in the acid joints, occasional small cysts were present in the cartilage.

H<sub>2</sub>O: In the joints which received water the changes in the synovial membrane were practically identical with those which had received acid. The cartilage in these joints was fibrillated and eroded and the underlying bone was exposed and eburnated, as in the acid joints, but the changes were more extensive. Likewise, there was somewhat more reaction on the part of the bone in the form of marginal and subperiosteal new bone formation.

NaCl (0.85 per cent.): In the joints which received normal salt solution the changes in the synovial membrane were practically identical with those in the joints which had received acid. In three of the sections small nodules of hyaline cartilage were found in the hyperplastic subsynovial tissue. The changes in the cartilage were similar to those which occurred in the joints which received acid, except that the zone of surface necrosis was not quite as deep. In some areas in the joints which received twenty-eight injections, the surface appeared to be living, while the deeper portion of the cartilage was dead, and in still other areas there was a narrow necrotic surface zone supported by a layer containing nests of living cells, and

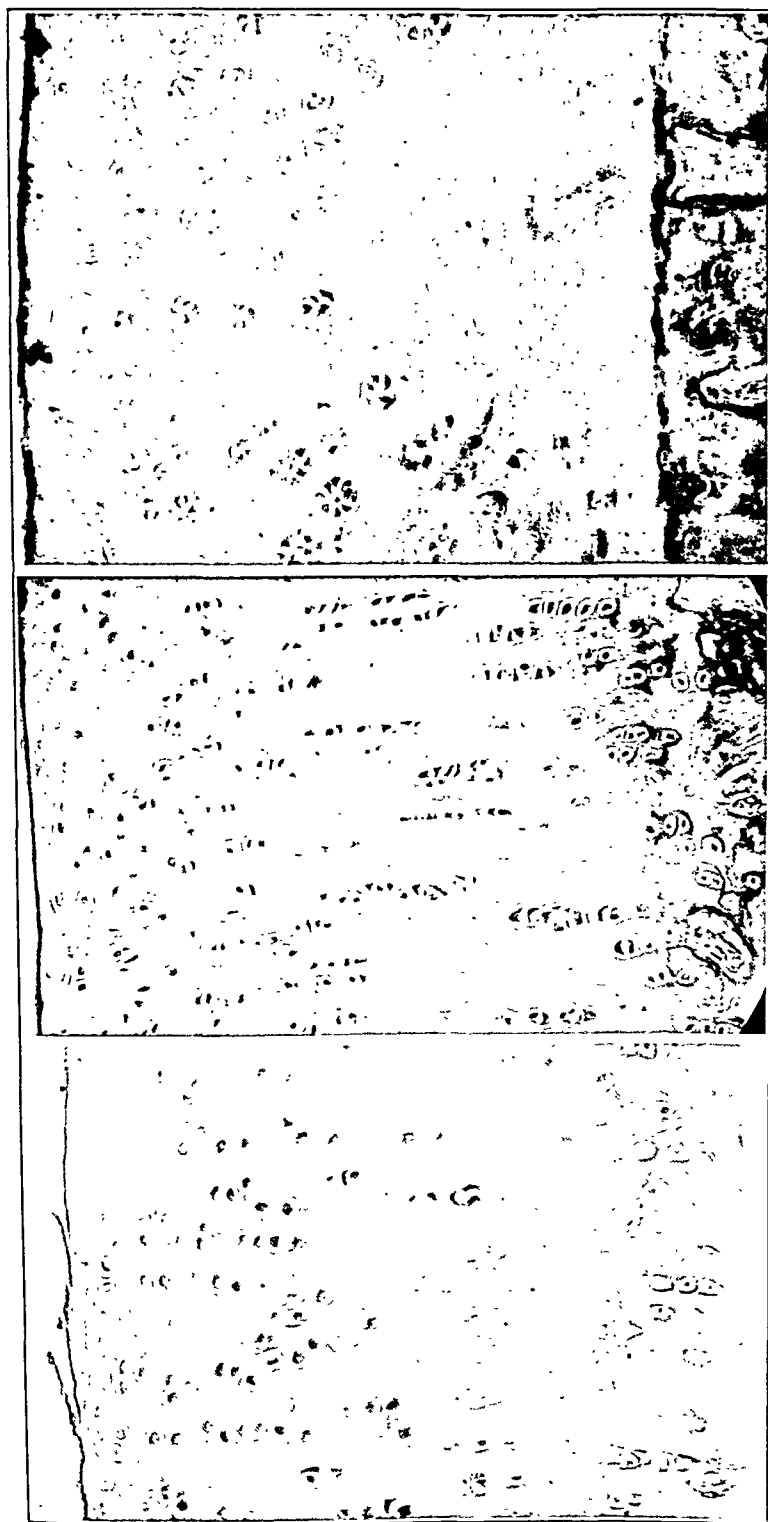


FIG. 3

Left: Cartilage from R 757-8 ( $\text{H}_2\text{O}$ ) showing necrosis and disappearance of cells in the deeper layers with fairly normal surface zone.  
Middle: Same joint as preceding, showing moderate regeneration in the form of cell columns in the deeper zone.  
Right: R 751-2 (0.85%  $\text{NaCl}$ ) showing necrosis and disappearance of cells in the depths of the cartilage with regeneration in the form of cell nests.





FIG. 4

Left: R 743-4 (HCl). Death of cells, especially in the deeper portions, with marked regeneration with the formation of large cell nests and surrounding zone of new matrix in the apparently dead cartilage.  
Right: R 780-1 (H<sub>2</sub>O). Localized areas of necrosis and cleft formation separated by a zone of almost normal cartilage.

beneath these there was necrosis of the deeper layers and the cartilage was beginning to separate from the underlying bone. On the whole these joints showed changes similar to those which had received acid and were of about the same degree.

In the joints which received injections of ten per cent. NaCl, there was in the early joints moderate synovial hypertrophy and hyperplasia in some areas and in the later joints there was rather marked fibrosis and some giant-cell formation. The cartilage showed surface necrosis with erosion over the bearing surfaces and fragmentation of the cartilage, but these changes were considerably less in degree than were those present in the joints which received acid or alkali or water or normal salt solution.

#### SUMMARY

Postmortem cultures of the joints yielded no growth; consequently, it may be assumed that the pathological changes which occurred in the injected joints were caused by the injected material. These changes can be summarized as follows:

1. *Synovial Exudate:* The acute joints (one and three days) contained a moderate excess of cloudy, straw-colored fluid and this fluid contained large numbers of leucocytes and macrophages. The subacute joints (five and ten days) also contained a moderate excess of cloudy, straw-colored fluid, but the leucocytes had largely disappeared and most of the cells were macrophages. In the chronic joints (twenty-eight to eighty-five days) the excess fluid was decreased in amount, relatively clear, and contained only a moderate number of cells (mostly macrophages).

2. *Synovial Tissues:* In the acute joints the areolar and adipose areas of the synovial surface exhibited a rather acute inflammatory reaction with hypertrophy and hyperplasia of the fixed tissue cells and infiltration of the tissues with leucocytes and small and medium-sized round cells. In the subacute joints the leucocytes had largely disappeared, but the round-cell infiltration of the loose subsynovial tissues was more marked and the hyperplastic synovial tissues tended to invade and overlap the margins of the articular cartilage. In the chronic joints the fixed tissue cells were about normal in size, but the synovial tissues were moderately thickened and infiltrated with small and medium-sized round cells (Fig. 2).

The fibrous areas of the synovial surface (including the fibrocartilage) showed relatively slight changes in any of the joints.

3. *Articular Cartilage:* A variable number of the cartilage cells were killed and the death of the cells was followed by fibrillation, cleavage, and disintegration of the matrix, and occasionally by separation of the superficial cartilage from the deep calcified zone. Where only a portion of the cells in a given area were killed, the small superficial cells tended to survive, while the larger cells in the deeper zones died (Fig. 3). When some of the deeper cells remained alive, they tended to proliferate and form cell columns and cell nests and the larger cell nests were surrounded

FIG. 5

Left: R 753-4  
(0.85% NaCl).  
Extensive death of  
cartilage cells with  
very little regenera-  
tion and beginning  
disintegration of the  
matrix in the deeper  
layers.

Right: R 745-6  
(HCl). Complete  
death of cartilage  
cells with disinte-  
gration and fibrilla-  
tion of the surface  
zone.



FIG. 5

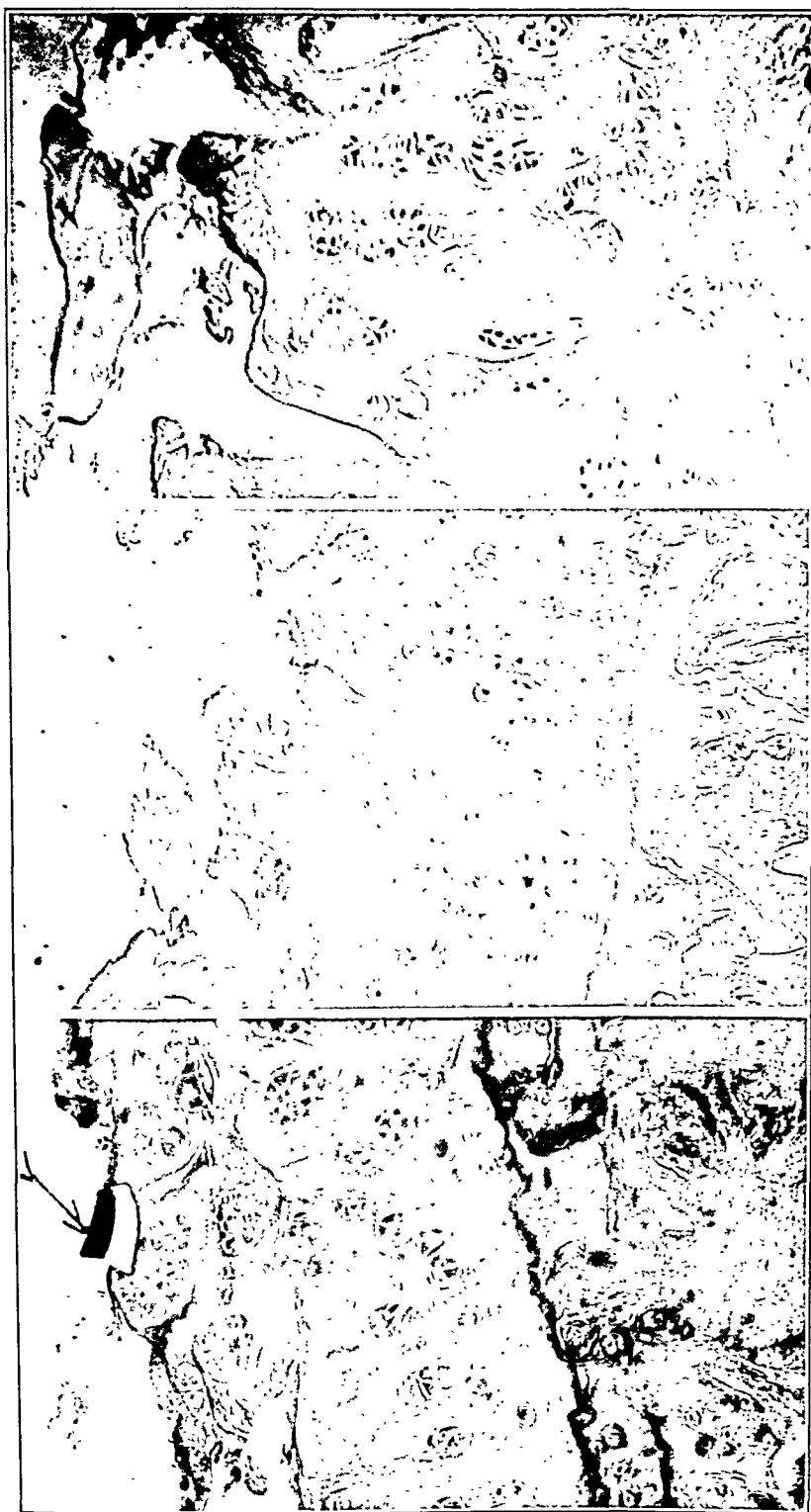


FIG. 6

Left: R 751-2 (0.85% NaCl) showing disintegration of surface with moderate regeneration and nest formation. (Arrow points to defect in the photomicrographic film).  
Middle: R 757-8 (10% NaCl). Similar to preceding, but very little evidence of regeneration.  
Right: R 780-1 (H<sub>2</sub>O). Similar to preceding with rather well marked regeneration and cell-nest formation.



FIG. 7

Left: R 743-4 (HCl). Cell death, necrosis, and fibrillation of cartilage with erosion of surface zone. A few cell nests are present.  
 Right: R 745-6 (HCl). Cartilage dead, almost completely eroded and underlying bone eburnated.

by zones of newly formed hyaline matrix (Figs. 3, 4, and 6). The small cells near the articular surface exhibited relatively little tendency to proliferate.

Occasionally the cartilage necrosis was sharply localized (Fig. 4, Right), but as a rule it was diffuse and was especially marked over the bearing surfaces of the joint. Here the surface tended to disintegrate and the cartilage was in many instances eroded and the subchondral bone was exposed (Figs. 6 and 7). In joints with considerable cartilage necrosis there was a variable amount of marginal proliferation of the articular cartilage.

4. *Bone*: When the articular cartilage was eroded the underlying bone became eburnated and the bone cells near the exposed surface died. Necrosis and erosion of the cartilage over the bearing surface of the joint were usually accompanied by proliferation of cartilage and bone around the margins of the cartilage (marginal osteophytes) and beneath the adjacent periosteum (exostoses) (Fig. 9). The combination of central necrosis and marginal proliferation caused deformities of the joint. These joints did not tend to ankylose by fibrous tissue or bone.

#### DISCUSSION

The pathological changes just described resemble those which occur in hypertrophic arthritis in human beings and which I have produced in the knees of rabbits by resecting a rectangle of cartilage from the patellar surface of the femur.<sup>6</sup> Likewise, the changes in the synovial exudate and tissues resemble those produced by the repeated injection of blood or by a single injection of India ink into a joint.<sup>7</sup>

In the experiments reported in this paper the arthritis was caused by the repeated injection of substances which were so innocuous that a single injection would cause no permanent changes in the joint. That neither the acid reaction (Seeliger) nor the hypotonic medium (Häbler) was specifically responsible for the arthritis is evident from the observations that practically identical changes were produced by acid and alkali in an isotonic medium and even by isotonic sodium chlorid solution.

From these experiments it is evident that the articular cartilage is the most vulnerable of the joint tissues. It is readily penetrated by fluids in the joint cavity and the cells (especially the deeper cells) are easily killed by chemicals, but apparently they have lost the power of proliferation. These two observations lend support to the theory that cartilage grows from beneath rather than from the surface and that the deeper cells are younger than those nearer the surface.

The repeated injections caused inflammation of the synovial tissues and death of the articular cartilage. When the irritation is removed, the synovial tissues tend to return to normal, but the damage to the cartilage is more or less permanent. As I have pointed out elsewhere<sup>6</sup>, when articular cartilage is killed, it is difficult for repair to take place because the cells cannot migrate through the dense matrix and the dead cartilage

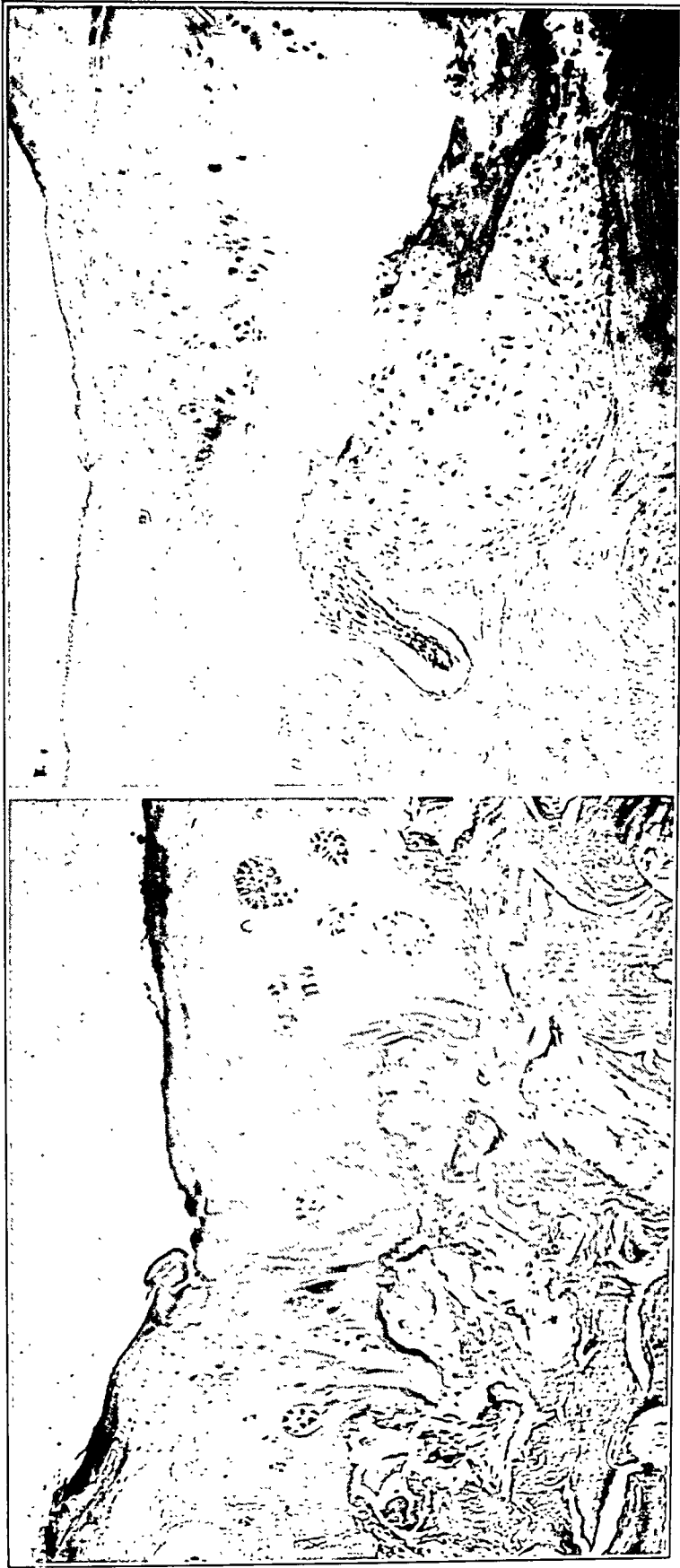


FIG. 8

Left: R 739-40 (HCl). Necrosis of cartilage and the underlying bone with beginning separation of cartilage in the form of cell nests.  
Right: R 745-6 (HCl). Almost complete necrosis of cartilage with regeneration in the form of invasion of the underlying bone by the cartilage.



FIG. 9

Left: R 713 1 (HCl). Complete disappearance of surface cartilage with defect in the bone which is partly lined by hyaline cartilage.

Right: Same as preceding. Low-power view of a marginal osteophyte, showing fibrous surface layer which merges into cartilage and this in turn merges into bone.



remains *in situ* and prevents repair by growth from the adjacent living tissue. Not only is this true, but, when the cartilage is injured so that a raw surface is exposed, the cells adjacent to this surface die. Furthermore, when the cells of cartilage are killed, the surrounding matrix tends to disintegrate. Consequently, the effect of repeated minor injuries to cartilage is cumulative.

It is thus evident that in these experiments the arthritis followed necrosis of the cartilage and one could interpret the results as corroborating Axhausen's theory that chronic arthritis is caused by the presence of dead cartilage in the joint. However, as I have shown elsewhere, simple removal of a portion of the articular cartilage results in exactly the same type of arthritis, and the presence of dead cartilage is not necessary.<sup>6</sup>

Consequently, I believe that the arthritic changes reported in this paper were caused by injury to the articular cartilage. Since I have produced almost identical pathological changes in joints by the injection of bacteria (diphtheroids and cocci of low virulence)<sup>8</sup> (Fig. 1), and by various types of mechanical injury, it seems reasonable to assume that chronic arthritis represents the response of a joint to injury. If the injury is largely limited to the articular cartilage and the joint continues to function, the result is hypertrophic arthritis, regardless of the type of injury. If the injury is due to an acute infection, the result is a pyogenic arthritis and the ultimate result depends upon the amount of destruction which occurs before the process is arrested. If the injury is a chronic irritation, chiefly affecting the synovial tissues, the result is an atrophic arthritis.

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# MAGGOTS IN TREATMENT OF OSTEOMYELITIS

## A SIMPLE INEXPENSIVE METHOD

BY DUNCAN C. MCKEEVER, M.D., KANSAS CITY, MISSOURI

*Departments of Orthopaedic Surgery and Pathology, St. Luke's Hospital*

The use of maggots in the treatment of osteomyelitis has been widely popularized by the work of the late Dr. William S. Baer<sup>1</sup> and by the wave of publicity which followed his investigation. Those reporting the use of maggots have found the treatment very satisfactory, and their results compare favorably with those obtained by other well known procedures. If the use of maggots for this purpose is as beneficial as the reports indicate, a further investigation of technique may be valuable.

In reviewing the literature to date, one is dismayed by the difficulties, the expense, and the time involved in the methods described. At present it is impossible for a small hospital to provide its own supply of sterile maggots, as the expense for necessary equipment as described by Baer would run into hundreds of dollars, and the culture and handling of flies and maggots would necessitate the employment of a trained, full-time technician. Sterile maggots may be purchased at a quoted rate of five dollars per thousand. This number is sufficient for one ordinary application. The number of applications necessary varies in Baer's series from one to thirty-six, with an average of eleven; at a cost of five dollars per application, the cost of maggots alone would average fifty-five dollars per patient. This cost is an important item when added to the expense of the usual prolonged hospitalization of patients with osteomyelitis. Therefore, a simple, inexpensive method, by which maggot treatment may be made available to anyone, has been worked out and will be described.

When Baer began his work, he used unsterilized maggots successfully until two of his cases developed tetanus. He then devised his elaborate and costly method of producing sterile maggots. Nevertheless, a prophylactic injection of tetanus antitoxin for all patients being treated is still advised, as a precautionary measure, by the firm selling sterile maggots. Unsterile maggots are just as efficient as sterile maggots in their action on the lesion and, had Baer given prophylactic antitoxin, his two cases of tetanus would not have occurred. The only pathogenic organism present other than tetanus was the gas bacillus. Baer proved by controlled experiments on guinea pigs that maggots protect animals from gas-bacillus infection. No cases of gas gangrene have been reported, whether sterile or unsterile maggots were used. There is, then, no valid reason why sterile maggots are more effective or safer than unsterile maggots. Livingston<sup>2</sup> has used unsterile maggots extensively at the Hines Memorial Hospital and there have been no unfavorable results in a large series of cases recently reported by him. Weil and Nettrour<sup>3,7</sup>, Rohm<sup>3</sup>, Goldstein<sup>4</sup>, Wilson,

Doan, and Miller <sup>5</sup>, Thorek <sup>6</sup>, Henry <sup>7</sup>, and Sweadner <sup>7</sup> have also used both sterile and unsterile maggots; and their results have not been noticeably different from those reported by Baer.

Contrary to described methods, the culture of flies and raising of maggots is amazingly simple. Under almost any conditions flies will live, lay eggs, and grow maggots if sufficient suitable food is supplied. The ease with which they can be grown may be suspected if the adverse conditions under which flies and maggots live and propagate in nature are considered. The varied conditions under which they may be grown make their controlled culture inexpensive.

In October, 1931, a supply of maggots was offered for use, in the treatment of osteomyelitis, on the service of Dr. Frank D. Dickson and Dr. Rex L. Diveley at St. Luke's Hospital. These maggots were raised on raw beef without any attempt at sterility. They were washed in a 1-1000 solution of bichlorid of mercury with twenty-five per cent. alcohol before introduction into the wound. Treatment of two cases of osteomyelitis of the hip was undertaken. Very little was known about keeping the maggots in the wounds and many escaped. Some of these were used as a stock supply and at present all our cases are treated with maggots descended from this stock.

There were no funds available for equipment,—such as incubators, cages, heating elements, thermostats, water-vapor controls, fans, etc., usually described as indispensable. A box of approximately eighteen by twenty-four by thirty inches was set on legs. Glass windows were fitted to the front. Two old thermostats from bacteriological incubators were reconditioned and installed, one being used as a safety unit. A 200-watt light was placed near the back of the box to supply heat. A pan of water

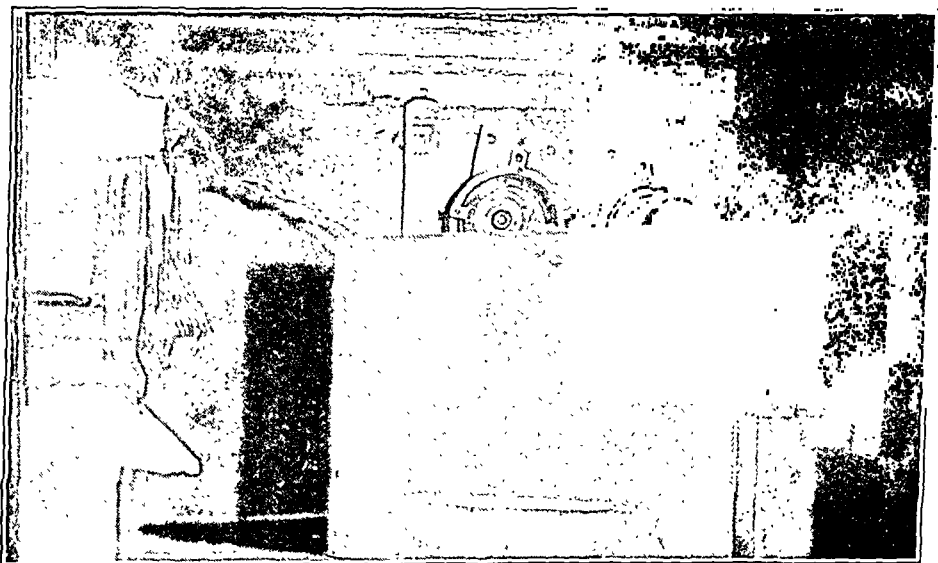


FIG. 1

Incubator showing thermostats, light to supply heat, pan for water, and shelf to shade maggots from the light.

was placed under it to provide moisture. No attempt was made to circulate the air. A small shelf was built in to hold the jars of maggots so they might be kept in the dark (Fig. 1). Any similar apparatus would be equally satisfactory. The temperature should be regulated from seventy to ninety degrees fahrenheit; the higher temperature promotes rapid growth of maggots but the flies live longer at the lower temperature.

The original stock of maggots was put on a piece of raw beef in a jar and in a few days reached adult size. Sand was poured on them and they crawled into it and formed pupae. These pupae were placed in a petri dish in a cage constructed as follows (Fig. 2): A flat box of a size that would easily fit in the incubator was secured. The top and bottom were replaced with screen wire and a small door placed in one end. The cage thus stands upright on one side of the box. The door should be at the bottom, as this prevents escape of flies when changing food and cleaning the cages. After about seven days, the pupae hatched to flies.

Flies are fed on a mixture of one ounce of honey, one dram of yeast powder, and eight ounces of water. This food is all the flies require. It should not be allowed to ferment and should be constantly present. The food was placed successively on cotton, sponge rubber, cloth, crackers, and in jars with wicks, but was found to require less attention when merely placed on a slice of bread in a petri dish. One such supply easily lasts forty-eight hours. About seven days after hatching, the flies are ready to lay and the eggs are most readily collected on a small bit of raw beef, measuring about one-half by one by one inches, which is placed in the cage on a bit of waxed paper. The eggs will hatch in eight hours or less at incubator temperature and must be removed before hatching if they are to be transferred to other media for growth. Meat should be placed in the cage for a few hours about every second day, for the purpose of collecting eggs. Meat, as a possible source of pathogenic organisms, may be entirely eliminated. The flies will lay on almost anything after about seventy-two hours. A small piece of agar will suffice, or the eggs may even be collected from the bread on which the food is placed.

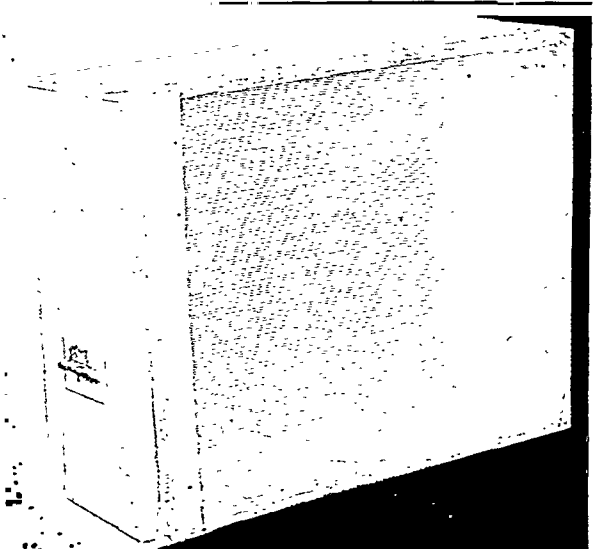


FIG. 2

Fly cage with a supply of food in place.

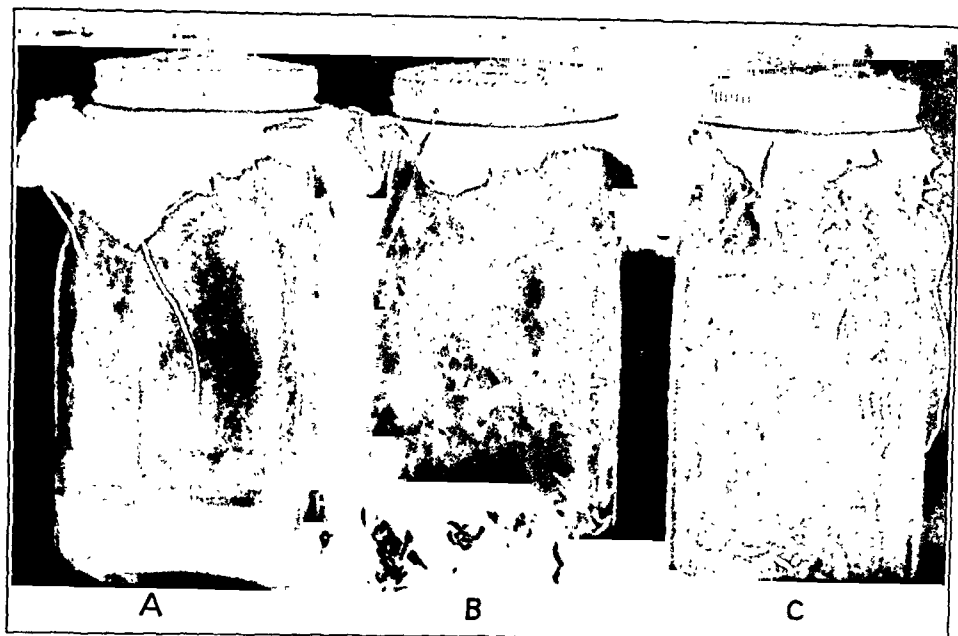


FIG. 3

- A. Fresh jar of media.
- B. Jar of media containing maggots forty-eight hours old.
- C. Maggots washed and ready for use or storing.

The media for culturing the maggots to proper size for use in treatment is prepared as follows: A circular hole is cut in the lid of an ordinary petrolagar jar. This hole should occupy almost the entire top. A piece of raw liver, about one inch in diameter, is put in and the jar filled to the level of the top of the liver with peptone agar to which yeast has been added in the proportion of about one cake to 1000 cubic centimeters. A single layer of old sheeting is placed over the top of the jar and the lid screwed in place over it. The jars are then autoclaved twice, with a twenty-four hour interval of incubation, and stored in an icebox until needed (Fig. 3-A). This is one of the media used by Baer. It is the only one needed and is very satisfactory.

Eggs are transplanted to this media. This is best done with a toothpick or small scalpel kept for the purpose. Each fly will lay over 100 eggs at a time and about four to six such layings can be raised to the size required in a jar of media made as above. The jars are then incubated until the maggots are the proper size for use. The rate of growth depends on temperature and relative food supply, and usually forty-eight to seventy-two hours are necessary. At this time the maggots will be about one-fourth inch long or slightly more (Fig. 3-B). During this growth period, care must be taken to keep the cloth cover dry so that it will admit air. If it becomes wet, due to maggots crawling over it, the air is shut off, and the maggots die in as short a time as six to eight hours.

When the maggots have grown to the proper size, the jars may be placed directly in the icebox until needed; but it is much more convenient and time-saving if several jars of maggots are grown to the proper size at the same time and washed up ready for use before storing. The washed

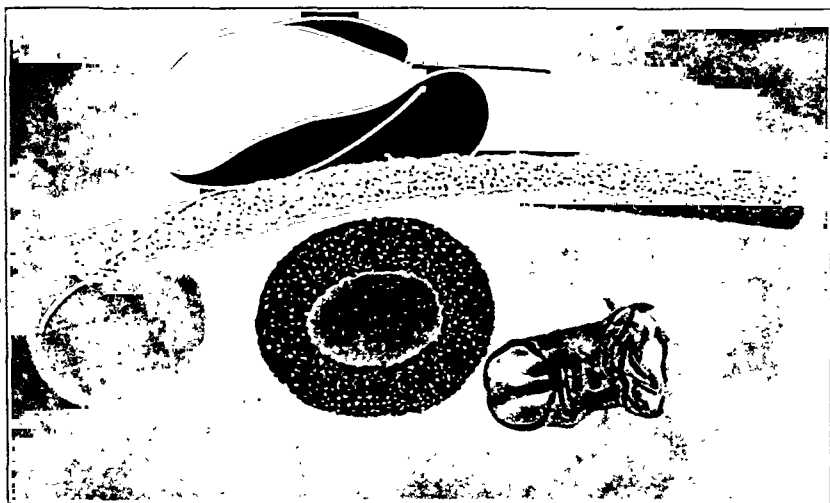


FIG. 4

- A. Method of edging screen with sponge rubber.
- B. Completed screen.
- C. Glass tube to be used in wound to allow drainage and prevent too early closing of the skin edges.

maggots will remain in good condition for a longer time than the unwashed ones. At first, considerable difficulty was found in separating the maggots from the media on which they were grown. However, it was noted that about twenty-five per cent. of them float in water and about forty per cent. float in normal saline. It was then only a step to the addition of about two tablespoonfuls of sugar to each jar after it had been nearly filled with water. When the proper amount of this is stirred into the solution, the maggots all float and leave the media in the bottom of the jar; but, if too much sugar is stirred in, particles of media also float. The maggots are then dipped into an ordinary tea strainer and are thoroughly rinsed with tap water and placed for thirty minutes in a 1-1000 solution of bichlorid of mercury with twenty-five per cent. of alcohol. They are then strained again and are ready for use. Placed in an empty media jar, they may be kept in good condition in an icebox for as long as two weeks (Fig. 3-C). When needed, these maggots may be removed, rinsed with ice water, and implanted in the wound. When cold, the maggots are almost inactive and much easier to handle.

Each generation of flies will live and produce eggs for about four to six weeks. For replacing the flies, one laying of eggs may be grown to maturity, on a large piece of steak, in about seven days. If the usual media is used, three jars of it will be necessary to grow one "laying" of eggs to adult maggots. Large jars of media may be prepared for this purpose. When adult in size (about one-half to five-eighths of an inch long), the maggots are transferred to dry sand and will pupate in about forty-eight hours. Maggots will also pupate in a wad of dry gauze. Pupae may be kept on ice, with only a small percentage of loss, from two to three

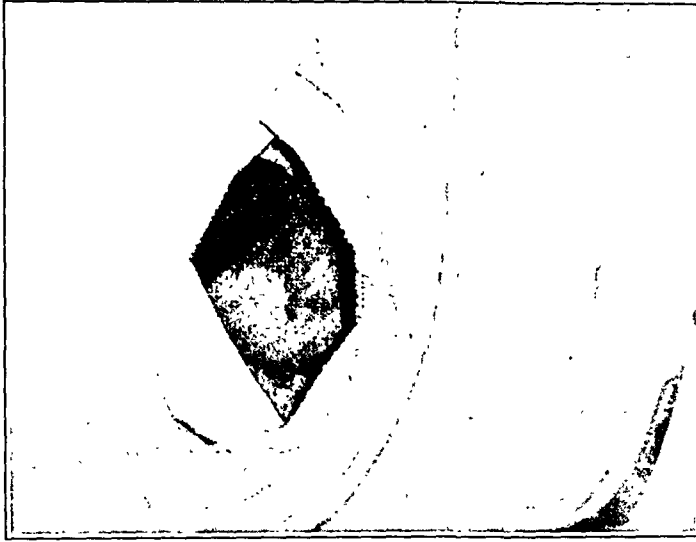


FIG. 5

Complete dressing on an extremity, showing screen held in place by adhesive and bandage.

weeks, possibly longer, before being placed in the incubator for hatching.

#### TECHNIQUE OF IMPLANTING MAGGOTS

In implanting the maggots and keeping them in the wound, there are several procedures which have been found useful. It is not necessary to the success of the treatment that all the maggots be kept in the wound, and one

worker who has used them in a large number of institutional cases makes no effort to keep them in. However, it is very imperative, in private practice, that the patient be kept comfortable or he will not submit to the treatment. If the maggots are strictly confined to the wound, the patient has no discomfort unless there are nerves exposed. If this is the case, the pain can be controlled with sedatives and will usually disappear after the second application. I find bromid and codein the most useful drugs.

The most important single consideration in keeping the maggots in the wound is the maintenance of adequate drainage in some way, so that the maggots can not escape by the same route. It is obvious that those maggots which escape the confines of the wound are useless therapeutically, and they cause constant annoyance to the patient. The only method which I have found satisfactory for keeping the maggots in the wound consists of placing a close-fitting, screened cage over the wound and taping it down tightly. This is not always effective but, with a little experience in application, the device will become about ninety-five per cent. efficient.

The screened cage is made by cutting a piece of 60-mesh milk-strainer wire (cost forty cents per square foot) to a size about one-fourth of an inch larger than the edge of the wound (Fig. 4-A). This may be done from a pattern, but a little experience will enable one to cut them without. A strip of sponge rubber of soft texture and about one-half inch thick is cut. This should be about one-half inch wide and a little longer than the circumference of the screen. It is folded over the edge of the screen and sewed in place with a close stitch drawn tightly (Fig. 4-B). Satisfactory screens may also be made by sewing edges of the milk-strainer wire between two strips of sponge rubber or inlaying it in a window in a flat piece

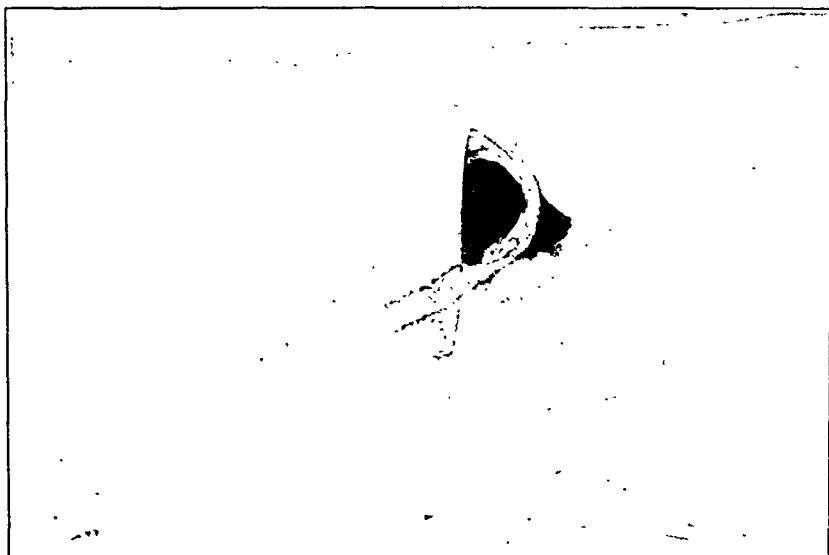


FIG. 6

Glass tube to maintain surface opening of wound, held in place by adhesive.

of sponge rubber and sewing it in place. These screens may be sterilized by boiling, but should be dry at the time of application.

The screens are applied in much the same manner as described by Child and Roberts<sup>5</sup>. The surrounding skin is cleaned with ether and a layer of flamed adhesive is applied to the edge of the wound. This is coated with liquid adhesive. The maggots are then put in the wound and covered with the screen cage which is tightly taped down, leaving the screen exposed. The tape should be applied in the manner of a basket splint in order to make pressure around the wound. If the screen is large, a narrow strip of adhesive may be drawn across the top to hold it firmly in place. If on an extremity, a snug bandage should be applied to hold the tape in place (Fig. 5). A pad is so placed as to catch the drainage from the wound but not to obstruct the access of light and air to the screen. The bandage and pad may be changed as often as necessary without disturbing the remainder of the dressing. The maggots are left in the wound for five days at each application, unless there is some indication for their removal at an earlier stage. If the drainage stops, the maggots are probably dead and should be removed, although the wounds do well even when the maggots are dead. Using a support for bed covers, a light may be placed to shine on the screen. The light drives the maggots deep into the wound and adds to the comfort of the patient. It should not be placed so close as to dry the secretions on the screen as this blocks drainage and results in quick death of the maggots. Between applications of maggots, a day's rest is given, the wound being tightly packed with dry gauze.

In all cases, there is a great tendency of the wounds to heal at the



outer edges. Often, if the outside opening is not particularly large, the wound will nearly close at the surface during one period of maggot treatment. In this case, a small glass tube about one-half inch in diameter and long enough to go nearly to the bone may be used (Fig. 4-C). The maggots then have access to the depths of the wound and good drainage is maintained. As the wound heals, a shorter tube may be used. The tube should be held in place with adhesive strips (Fig. 6). The usual dressing is applied over the wound.

Some workers report that the maggots live only a few hours in the wound after the first application and believe this is due to some substance secreted in the wound by the body or to some substance resulting from the maggots' own metabolism. It does not seem logical that the maggots would themselves produce a substance which would result in their death, and in nature maggots live to maturity in open wounds on live animals. I am of the opinion that, if the maggots die, it is a result of inadequate drainage. In culture, they die if too much moisture is present and if air is excluded. We have cases which have had many applications, in which the maggots live five days if good aeration and drainage are maintained. The progress of these cases is as satisfactory as any in which maggots have been used. I have seen the dressings of one worker who makes no effort to keep the maggots in the wound and merely covers the wound with a large gauze dressing. This dressing rapidly becomes soaked with secretion and it would be remarkable if the maggots did live long under it.

The usual advice is to completely fill the wound with maggots. This usually results in death of many of the maggots in a few hours because the drainage is blocked. If the maggots do live, they grow and crowd off the screen and escape, causing the patient great discomfort. I try to put in a number which I think will approximately fill the wound when they are at the adult stage of growth. This is about one-fourth to one-third of the wound volume when the maggots are at the three-day stage. The maggots rapidly seek out and devour all available food and continue working for a full five days.

After the bone is completely covered with granulations, the question of secondary closure of the wound arises. If the maggot treatment is continued, the wounds will eventually heal to skin level; and, in cases with only local bone involvement and a small wound, this is perfectly satisfactory and healing may be completed in as short a time as four weeks. In cases with extensive bone involvement and a wide incision, the healing is progressively slower and, near the end, may be completely arrested. One worker recently told me that the greatest difficulty was encountered in the final stages of healing of the soft tissues. If the wound does heal, the resulting scar is wide and thick, the circulation rapidly becomes poor, and, if subjected to trauma, it may break down. If secondary closure is done after all bone is healed over, the formation of a large mass of scar tissue is avoided, and the wound closes rapidly and with a much better cosmetic result. Certainly, the course of the treatment is greatly shortened and

subsequent breakdowns in the soft tissues are less likely to occur. It is not necessary to prepare the wound for closure other than to cleanse it with saline irrigations. If thought advisable, the wound may be dakinized or cleansed otherwise. In one case, we removed maggots and closed the wound on the second day thereafter. It remained closed after a few days of slight drainage. Like most secondary closures, these wounds usually partly break down and then heal rapidly.

#### SUMMARY

1. A method is presented by which maggots may be raised for use in a hospital or private practice.
2. Very little time is required in culture and growth of maggots by this method.
3. The expense for equipment is almost negligible since most of the apparatus is home-made.
4. If the maggots are properly applied, any slight discomfort to the patient is easily controlled.
5. If proper drainage is maintained, the maggots do not die in the wound.
6. Secondary closure of the wounds, after the bone is covered with granulation tissue, is advisable if the wounds are extensive or in a position exposed to trauma.

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# THE USE OF COLLOIDAL SULPHUR IN THE TREATMENT OF ARTHRITIS

BY THOMAS F. WHEELDON, A.M., M.D., F.A.C.S., RICHMOND, VIRGINIA  
*Chief of Orthopaedic Out-Patient Department, Medical College of Virginia*

AND ROLLAND J. MAIN, PH.D., RICHMOND, VIRGINIA  
*Assistant Professor of Physiology and Pharmacology, Medical College of Virginia*

The use, during the past two years, of intravenous and intragluteal colloidal sulphur in the form of sulphur diasporal, \* in 250 cases, each receiving from ten to one hundred injections, has led the writers to believe that this material has a very definite place in the treatment of arthritis. (Clinical data soon to be published justifies this statement.)

As little could be found in the literature relative to the use of sulphur itself in the treatment of arthritis, it was felt that assurance as to the toxicity or non-toxicity of this product should be had at the beginning. Clinically, in the injection of several thousand doses there have been no unfavorable reactions to the material, except in one case. This, the investigators are firmly convinced, was a pseudoreaction or rather a simultaneous reaction from another cause. The patient herself, of course, felt the reaction to be due to the administration of the sulphur.

As the first phase of a multiphased piece of research which the investigators are carrying out, they wish to here present sufficient evidence that this preparation is found not harmful in clinical doses. In the present series of cases, investigation has been confined to the hypertrophic type of arthritis.

Several investigators have shown that the parenteral toxicity of colloidal sulphur depends upon its dispersion and the speed of injection, especially for intravenous administration <sup>1, 2, 3, 4</sup>. The relation between dispersion and toxicity is probably due to the fact that the toxic effects of colloidal sulphur are apparently dependent upon the rate and amount of  $H_2S$  formation *in vivo*. A finely divided sulphur preparation offers a much greater surface to the reducing action of the tissues, and consequently the rate of  $H_2S$  formation will be much higher than that of another preparation with less dispersion, and with less active surface of the sulphur particles. Because of this fact, Messini <sup>1</sup> found the toxicity of various colloidal sulphur preparations to vary from seven milligrams to 315 milligrams per kilogram of body weight (intravenously in rabbits). He also noted the effect of age and concentration of these preparations upon toxicity, which effects can be explained on the basis of dispersion changes.

Messini demonstrated that a distinct inverse relationship exists between the intravenous toxic dose and the injection time. The M.F.D. (minimal fatal dose) of one preparation varied between thirty-two and

\* The material, sulphur diasporal, used in the investigation reported in these papers was donated through the courtesy of J. Doak Company, Inc., of Cleveland, Ohio.

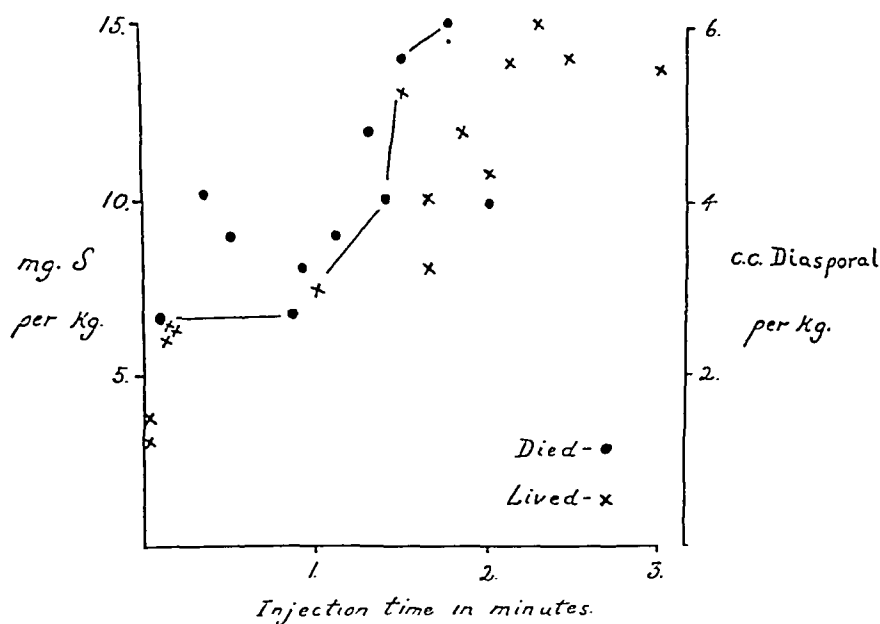


FIG. 1

This demonstrated the inverse relationship between the M.F.D. of aqueous sulphur diasporal and the time of injection, as administered intravenously in rabbits.

ninety-seven milligrams per kilogram of body weight (rabbit) with injection times of from one to nine minutes.

Because of these factors, the toxicity of a colloidal sulphur preparation cannot be judged entirely from its sulphur content, but must be determined experimentally.

Another important detail to be considered, concerning the intravenous administration of a colloidal substance, is colloidal shock: the so called "anaphylactoid shock" of Hanzlik and Karsner<sup>5</sup>. These workers showed that intravenous injection of such colloids as carbon, kaolin, etc., produced severe symptoms in experimental animals. Other investigators have reported<sup>6, 7, 8, 10, 11, 12, 13, 14</sup>, on these facts also.

Sulphur diasporal is supplied in two forms: a two-cubic-centimeter ampule, stated to contain five milligrams of colloidal sulphur dispersed in a protein-free aqueous medium for intravenous medication, and a two-cubic-centimeter ampule containing twenty milligrams of colloidal sulphur dispersed in olive oil, for intramuscular injection. The term "sulphur diasporal" will henceforth be abbreviated to "S.D."

The following are the findings of the writers relative to the toxicity of colloidal sulphur:

Four sets of experiments were carried on in animals.

Experiment 1 consisted of the injection of aqueous S.D. and intramuscular S.D. into the peritoneum of guinea pigs. The toxic dose of the aqueous S.D. ranged between thirty milligrams and 40 milligrams per kilogram of body weight. The toxic dose of the S.D. in oil (intragluteal)

is 220 milligrams per kilogram of body weight. The discrepancy between the toxicities of the aqueous (intravenous) and the oil solutions (intragluteal) is probably due to the more rapid absorption of the aqueous preparation and also, possibly, to its irritant effect.

Experiment 2 consisted of the investigation of the intravenous toxicity for rabbits. Here the toxic dose ranges from six and six-tenths milligrams of sulphur per kilogram of body weight, when injected in five seconds, to fifteen milligrams of sulphur per kilogram of body weight, when injected in 104 seconds.

The explanation for this relationship between toxicity and rapidity of administration may lie in the fact that the  $H_2S$ , formed from the action of blood on the sulphur, is excreted by the lungs, as has been proven by placing lead acetate paper over the animal's nostrils <sup>1, 2, 3, 7, 8, 9</sup>. When sulphur is administered rapidly,  $H_2S$  accumulates in the blood stream faster than it is removed, until it reaches a fatal level. During a slow injection, however, the  $H_2S$  may be excreted as rapidly as formed, and hence will not accumulate.

Experiment 3 consisted of the investigation of the effect of intravenous injections in an anaesthetized dog. Rapid injection produced a fall of blood pressure, which immediately rose a little above normal and then declined to normal level. When the material was injected slowly, no change was noted either in the blood pressure or respiration. An electrocardiogram showed no abnormality.

Experiment 4 consisted of the investigation of the chronic effect of intramuscular injection in dogs. This experiment indicated that no harmful effects were produced by this material even when given in rather large doses repeatedly over a long period of time. These laboratory findings seem to indicate that colloidal sulphur does not have any acute toxic effect. Moreover, except for unimportant local reactions no other investigators have reported deleterious effects, even in humans.

#### SUMMARY

The minimal fatal dose of the colloidal sulphur preparation (sulphur diasporal) used in the treatment of arthritis was determined by intraperitoneal administration in guinea pigs and intravenously in rabbits. The effects of intravenous administration on the blood pressure and respiration of dogs are reported, as well as the effects of a series of intramuscular injections. These toxicological studies would not indicate that this preparation is harmful in clinical doses.

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## SHORT METATARSAL BONES AND THEIR RELATION TO POLIOMYELITIS

BY ALBERT B. FERGUSON, M.D., NEW YORK, N. Y.

*Director of Roentgenology, New York Orthopaedic Dispensary and Hospital*

This article deals with those cases in which one or more of the metatarsal bones from the second to the fourth is short relative to the others, with no evidence of other malformation, fracture, or disease. Such cases are usually referred to as congenital malformations, but this is rarely the cause of the shortening.

Forty-two of these cases of simple shortening were studied,—fourteen males, twenty eight females, aged nine to fifty-seven, average twenty-two. In fourteen cases each foot was affected. In the fifty-six affected feet the fourth metatarsal was short forty-three times, the third twenty-five times, the second twenty-two times. The short bones were from sixty to ninety-five per cent. of their proper length. The right foot was affected thirty-one times, the left twenty-five times.

One of these cases was seen at age seven. At this time there was no short metatarsal, although the whole right foot was underdeveloped due to poliomyelitis. This case was seen again at age eleven, at which time the right third and fourth metatarsals were only ninety-four per cent. of their proper length, the shortening being due to premature union of the epiphyseal lines. Obviously the deformity was not congenital in this case.

Twenty-seven of the forty-two patients were known to have had poliomyelitis, seven probably had had it, five may have had it, and three had no history or muscular weakness suggesting it. In two cases there were congenital club feet. It is evident that the deformity is usually a sequel of poliomyelitis, and the presence of the deformity is strong evidence that the patient has had that disease unless congenital club-foot is present.

To determine the relation of poliomyelitis to the development of this deformity the twenty-seven cases known to have had poliomyelitis were studied. In all of the cases in which the length of leg was recorded (nineteen), there was a short leg on the affected side, or on one side in bilateral cases. The shortening was from three quarters to three inches.

The anterior tibial muscle was completely paralyzed in twenty-one cases, weak in five, and strong in one (which showed only a trace of shortening of two metatarsals). In the fifteen cases not known to have had poliomyelitis, this muscle was completely paralyzed in three, weak in two, spastic in one. No other muscles of the leg were so constantly affected.

In the twenty-seven poliomyelitis cases, the paralysis occurred between the ages of nine months and five years, only three being more than

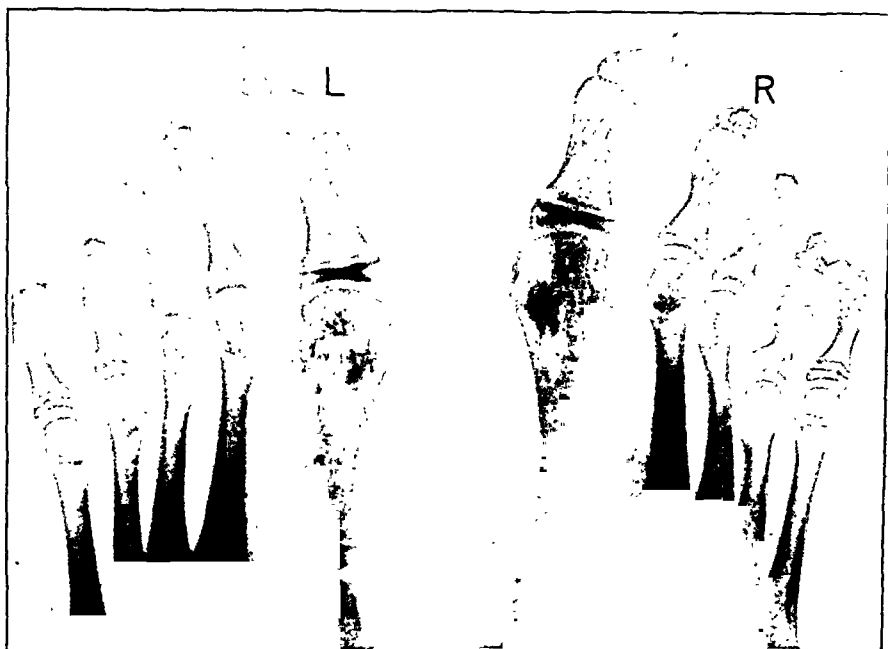


FIG. 1

Simple shortening of the right fourth metatarsal bone relative to the other metatarsals due to premature union of its epiphysis. Note that the proximal phalanx of each third and fourth toe is also short due to premature epiphyseal union. Female, aged ten.

three years old at the time of the attack, but no short metatarsal was noted under age nine.

Twelve of the poliomyelitis cases had had operations—such as subastragaloid fusion or astragalectomy—before a short metatarsal was noted, but when a short metatarsal bone was noted before an operation there was no subsequent change due to the operation.

It seems that shortening of the second, third, or fourth metatarsal bone appears early in adolescence, due to premature union of the epiphysis in patients who have had poliomyelitis early in life, usually before age four, with extensive paralysis of the limb at the time of the attack, and particularly when the anterior tibial muscle has been affected.

Examination of a number of poliomyelitis cases (including thirty patients over ten years of age), in which there was no relative shortening of a metatarsal, showed that they failed to meet the usual conditions in one or more of the following particulars:

1. Poliomyelitis did not occur before age four.
2. Paralysis in the leg had not been extensive and prolonged.
3. The leg was not short.
4. The anterior tibial muscle was not affected, or had rapidly recovered its power.
5. The patient had not reached the age of adolescence.



In poliomyelitis the whole foot may be underdeveloped but this does not prevent relative shortening of a metatarsal. Of the poliomyelitis cases in this series nine had underdevelopment of the foot.

It should be noted that the proximal phalanx of the toe is usually short when the metatarsal is short, but not always in the same degree. Also, the proximal phalanx may be short when the metatarsal is not affected (two cases). The shortening of the phalanx is due to premature union of the epiphysis.

#### SUMMARY AND CONCLUSIONS

Forty-two cases of simple shortening of the second, third, and fourth metatarsal bones were studied.

The deformity is a sequel of poliomyelitis in most cases and its presence is strong evidence that the patient has had that disease unless congenital club-foot is present.

The deformity tends to occur in those cases in which there has been extensive paralysis of a leg early in life (before age four) with involvement of the anterior tibial muscle, but the deformity does not appear until early adolescence, when the epiphysis unites prematurely.

In no case in this series did the deformity appear to be a congenital malformation.

# AMPUTATION STUMPS OF THE LOWER EXTREMITY

BY MAJOR N. T. KIRK, WASHINGTON, D. C.

On the functional value of the stump alone, when properly fitted with the present-day prosthesis, must be based the selection of the site of amputation and the technique of the operative procedure. When contemplating an amputation, the surgeon should, therefore, not lose sight of the fact of the prosthetic limitations and requirements as to the type of weight-bearing,—the length and adaptability of the stump. The stump, then, must be formed to meet the requirements of weight-bearing and locomotion as required by available types of prostheses. It has been found that certain sites of amputation give better functioning stumps than others. Many of the older sites of amputations, as well as methods and technical detail found inferior, have been discarded.

Lisfranc disarticulated through the foot at the metatarsal-tarsal articulation, causing a muscle imbalance in the stump, due to partial loss of insertion of the tibialis anticus and peronei (Fig. 1).

Chopart disarticulated through the mid-tarsal joint, causing still greater muscle imbalance with loss of the ankle extensors, and thus forming an insecure stump which soon develops a persistent equinovarus deformity,—a stump which is usually painful and useless.

Sir James Syme of Edinburgh in 1843 first described the supramalleolar amputation, which bears his name. The saw line is one-half inch above the lower articular surface of the tibia and parallel to the long axis of the leg. A heel flap is dissected from the os calcis and brought up over the bone end. When successful, it provides a stump, fully end-bearing, trans-

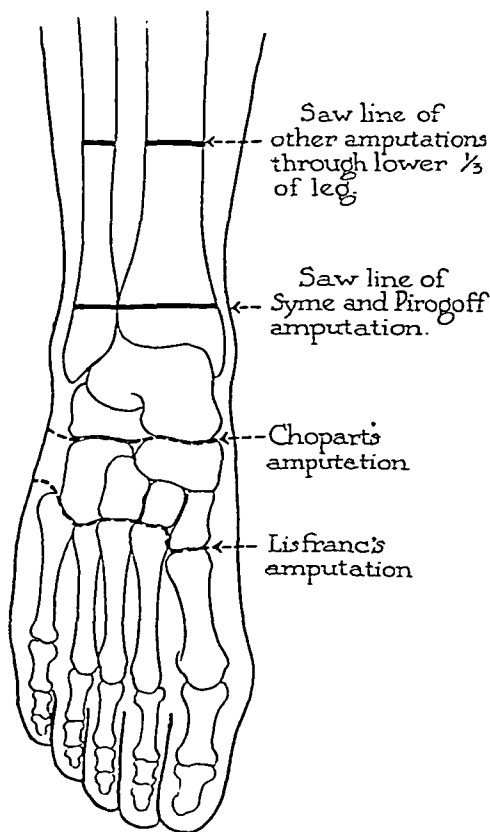


FIG. 1

Sites of amputations accepted by many authorities as giving ideal stumps. Considered inferior by the author from a functional standpoint, except on rare occasions, to an amputation through the lower part of the middle third of the leg.

mitting the entire body weight without pain, which can be used without the aid of a crutch or prosthesis for a limited distance in case of emergency. Unfortunately, all Syme's stumps are not ideal, usually the result of faulty surgical technique. Frequently there is a redundancy in the stump end, which is difficult to prevent, and which causes instability as it rolls under the bone of the stump end. If infection follows or the circulation of the heel flap is interfered with in the dissection, the stump fails. Huggins states that the Syme's stump, which is not entirely end-bearing, is inferior from a functional standpoint to an amputation through the leg. He finds such stumps not uncommon.

Pirogoff modified Syme's technique by leaving the posterior part of the os calcis in the heel flap, thereby producing an osteoplastic amputation. This was devised, not primarily as an osteoplastic procedure, but to overcome the difficulties in dissecting the os calcis and the incident necrosis from interference of blood supply in the formation of Syme's stump. It has the advantages of the Syme's stump in direct end-bearing, but further disadvantages from a prosthetic standpoint. The stump end in both these amputations is bulbous, making the prosthesis very apparent and unsatisfactory at the ankle. Due to their lengths, they are fitted with difficulty by the average prosthetist. The objectionable thigh cup and shoulder straps required by the usual below-knee prosthesis, however, do not have to be used. The best type of Syme's prosthesis I have seen was described by LeMesurier in *The Journal of Bone and Joint Surgery* for April 1926 (VIII, 292). The Pirogoff stump is so long that an ankle joint cannot be incorporated in the prosthesis without its making the extremity longer than the normal leg. A Syme's amputation should be considered in the laborer who has to be on his feet continually, or in one who cannot afford to buy the present-day prosthesis. Conditions requiring amputation of the leg will in the greater number of cases fall above the Syme's line, however.

An amputation through the lower third of the leg gives an unsatisfactory stump. The tibia at this level has no muscle insertions and is covered mainly by tendons. The circulation of the skin is poor, it tends to become cyanotic, heals poorly, and is easily traumatized. The length interferes with the ankle mechanism in the shin piece of the prosthesis. It possesses no advantages because of its length.

It is believed that the stumps giving the best functional value below the knee are obtained by amputation either through the bases of the metatarsal bones beyond the insertion of the leg muscles, or through the middle third of the leg, giving a stump length of not more than seven inches or less than five and one-half (Fig. 2).

The site of election in the leg amputation is through the middle third. The technique of the operative procedure to form an ideal stump at this or a higher level is as follows (Fig. 3):

The saw line is selected, measuring from the insertion of the internal hamstring tendons when the knee is flexed to a right angle. The fibula is

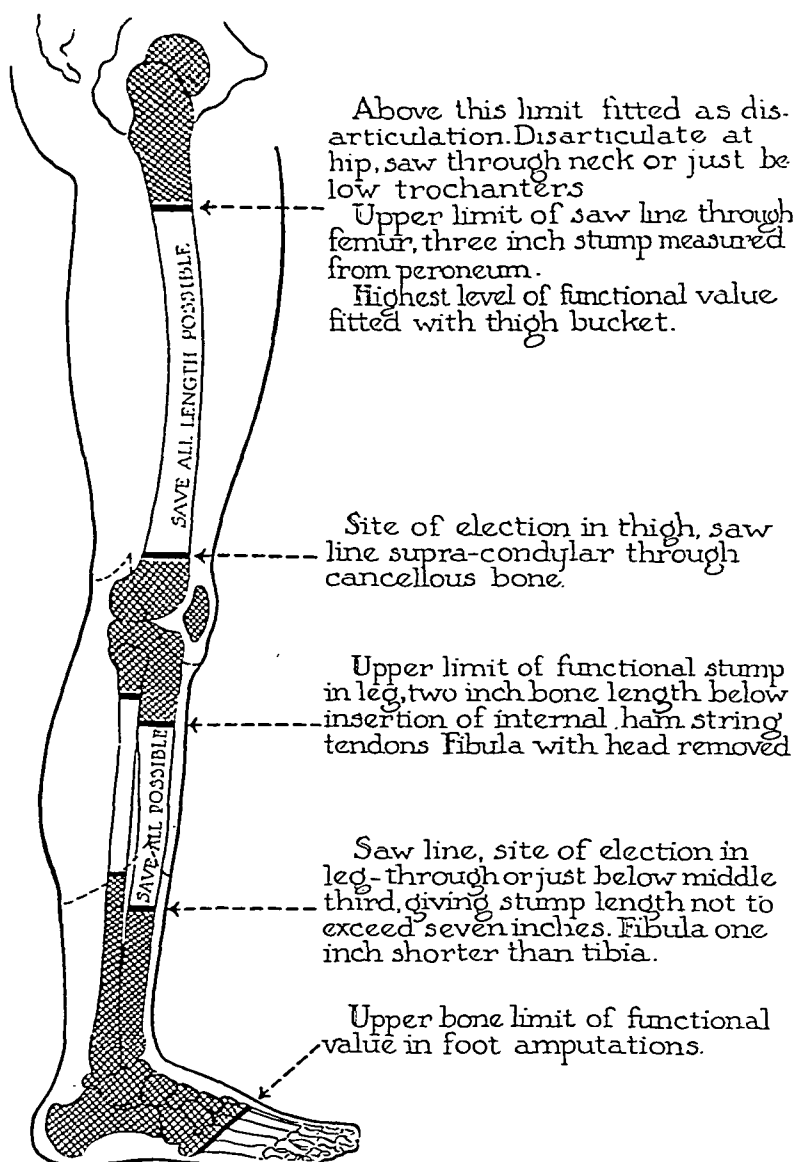


FIG. 2

Sites of election, lower extremity, giving best functional value.

sawed one inch shorter than the tibia, and, in the short below-knee stump, is removed *in toto* with its periosteum. Anterior and posterior skin flaps are formed in relation of three to two as to length. The anterior skin flap begins in the mid-lateral axis of the leg, extends downward, and slopes gradually across the front of the leg and backward to the mid-lateral axis of the other side. The incision begins just above the selected saw line and is carried through the skin only. This flap is dissected back to the saw line. The posterior skin flap is similarly cut, and is dissected back for about

one-half inch. The skin on the posterior surface of the leg, distal to the posterior skin flap, is cut away for two to three inches. The fascia so far has not been disturbed. The anterior skin flap is retracted to the saw line. The fascia and the muscles between the tibia and fibula, made up of the anterior tibial group of muscles, are cut through so that they will retract to the saw line. A long-bladed amputating knife is thrust through the muscles at the saw line just behind the fibula, coming out through the muscle posterior and against the tibia. A long muscle-tendon-fascia flap, triangular in shape, is formed from the posterior muscle group, which

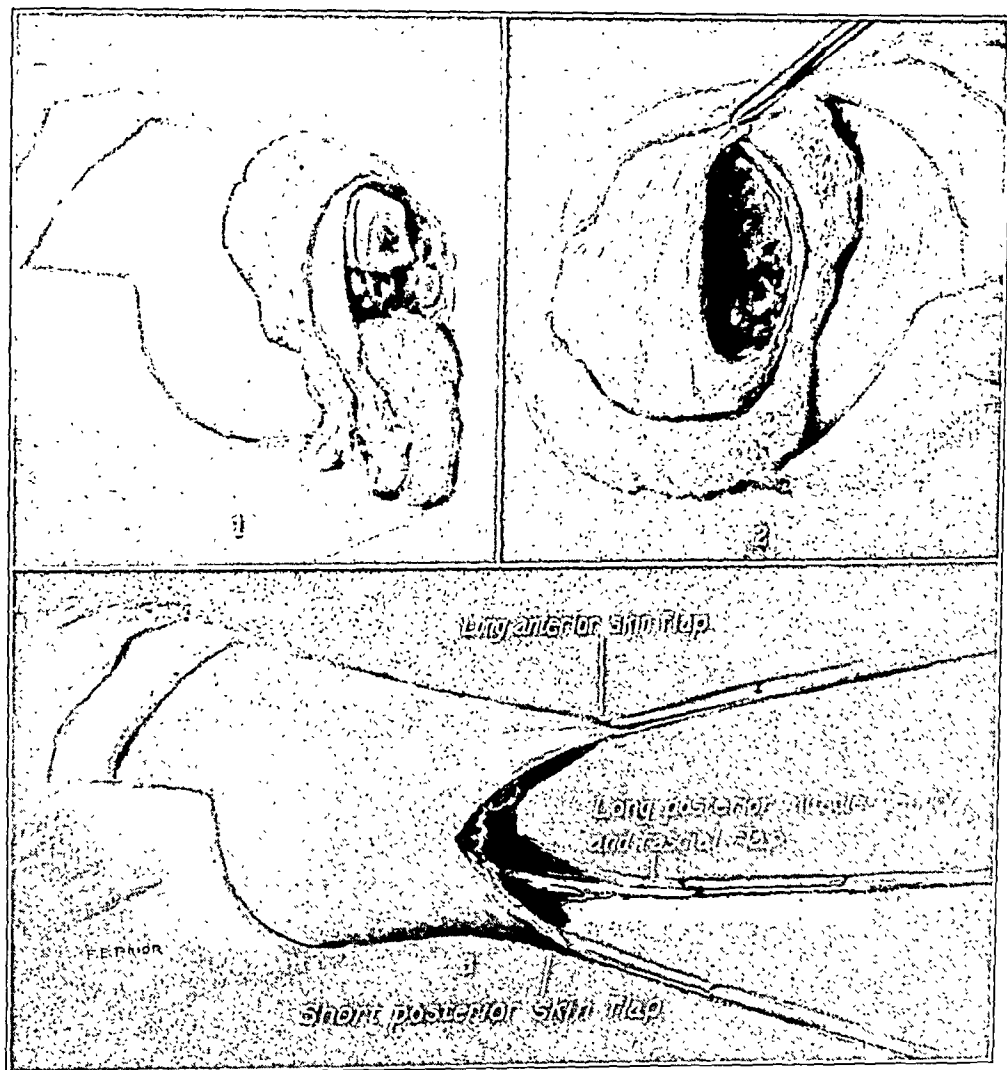


FIG. 3

Diagram of amputation through middle third of leg.

1. Anterior and posterior skin flaps turned back. Tibia sawed through and crest beveled. Fibula has been cut shorter than tibia. Long posterior muscle-tendon-fascia flap. Fascia and muscle between tibia and fibula on anterior lateral surface of leg has been cut to retract to the saw line.

2. Posterior muscle-tendon-fascia flap pulled up over stump end. Apex covers beveled crest of tibia. Inner margin in contact with mesial surface of tibia, and outer margin ready for suture to muscle and fascia between tibia and fibula. A rubber tissue drain is inserted under this flap.

3. Flaps pulled down by forceps to show relative length and position.

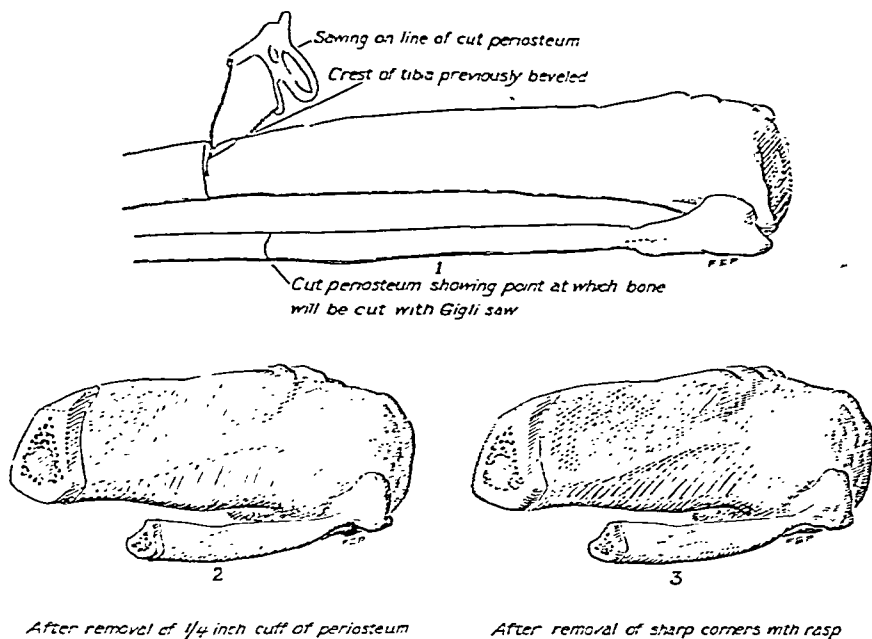


FIG. 4

Diagrammatic representation of the various steps in an aperiosteal amputation through the middle third of the leg. 2 and 3 are foreshortened to show the bone end to better advantage. A one-quarter inch cuff of periosteum has been removed and the edges smoothed off with a rasp. The endosteum has not been disturbed.

includes the origin of the tendo achillis, by cutting downward and backward. It is cut sufficiently long to cover the stump end. The periosteum is cut circularly around the tibia at the saw line and above this level at the point where the crest of the tibia later will be beveled. The muscle is cut away from the fibula to an inch above the saw line of the tibia and the periosteum is cut through circularly around the bone. The soft parts are gently retracted. The crest of the tibia is beveled, and the tibia sawed through at right angles to the long axis of the leg. The fibula is sawed through with a Gigli saw. The periosteum is cut circularly around the tibia and its beveled crest, and from the fibula one-fourth inch above the saw line, and removed, care being taken not to shred it. The sharp corners of the tibia are rounded off with a rasp. Sharp bone-cutting forceps are used to better advantage in rounding off the fibula. If the tibia is not rounded off, there will be three sharp points to protrude through the skin, instead of the one originally presented by the tibial crest before it was beveled (Fig. 4). All bone dust and periosteal fringes are washed from the muscle with a flush of normal salt solution.

The posterior muscle flap is thinned down by cutting away the muscle substance from its anterior surface, so that it will not be more than one-quarter inch thick at its base and one-eighth inch thick at its apex. The flap is brought up into position over the bone end and properly trimmed to fit. The inner border of the flap will eventually be sewed to the fascia



FIG. 5

The ideal below-knee stump amputated at site of election by method here described.

and periosteum covering the inner surface of the tibia. The outer border will be sutured to the cut fascia and muscle between the tibia and fibula and the apex of the flap will be pulled over to cover the beveled crest of the tibia. The anterior and posterior tibial and the peroneal arteries are located and ligated. The anterior and posterior tibial, and the musculocutaneous nerves are secured, pulled down while the muscle is retracted, tied with plain catgut, injected with absolute alcohol, cut with a sharp knife, and allowed to retract. The musculocutaneous nerve runs parallel to and between the deep fascia and the muscles on the outer side of the fibula.

The tourniquet is removed and all bleeding arrested. The triangular posterior muscle-tendon-fascia flap is brought up into position from behind and held in place by a towel clasp. As stated above, the inner side of the flap is sutured with interrupted catgut to the periosteum and the fascia covering the inner surface of the tibia, the outer side to the fascia and the anterior tibial group of muscles between the tibia and the fibula which were originally cut to retract to the saw line. The tip of the flap is pulled over and covers the beveled crest of the tibia and is secured by suture in this position. A rubber tissue drain is inserted under the muscle flap and emerges through the suture line from the outer side of the wound. The skin flaps, after being reshaped if necessary, are sutured under slight tension with interrupted non-absorbable suture.

A sterile gauze dressing is applied, the stump tightly bandaged and covered with a cotton gauze pad. A posterior, well padded, board splint, extending from the upper third of the thigh to beyond the stump end, fixes the knee in extension. The drain is removed when the stump is first dressed at the end of forty-eight hours. To prevent flexion contractions in the knee, the splint is maintained in position until the wound is healed. Such splinting is necessary in all below-knee amputations.

This technique gives an ideal stump with the suture line just posterior to the bone end, without redundant soft parts, ideal in length, with freely movable skin (Fig. 5). The bone end soon becomes rounded off, painless,



FIG. 6

The bone end of a below-knee stump using the aperiosteal method. It is rounded off, there are no spurs, and it is painless.

and free from spurs (Fig. 6). There is no large pad of muscle tissue to postoperatively pull away from the anterior surface of the stump, where it was sutured, or later to become a degenerated mass of oedematous, tender, and painful scar tissue. This stump is ready for fitting with its prosthesis six weeks following amputation, when healing occurs by primary intention. It takes its bearing on the shelving inner surface of the tibia below the tibial spine, and is reinforced by cone or lateral surface-bearing. This type of weight-bearing is inferior to end-bearing as afforded by the Syme's stump.

The thigh, like the leg, is roughly divided into thirds. The stump length is measured from the crotch to bone end of the stump. The functional value in the thigh stump rapidly diminishes above the lower third, due to the fact that at this level an end-bearing stump can be formed and so fitted. Either the Gritti-Stokes or the supracondylar tendoplastic method may be employed. Gritti in 1857 described his supracondylar osteoplastic amputation, which was slightly modified by Stokes in 1870. It is an osteoplastic method of amputation, in which the patella, after its articular cartilage is removed and its posterior surface made flat, with its covering soft parts and attached quadriceps tendon, is fitted to the sawed



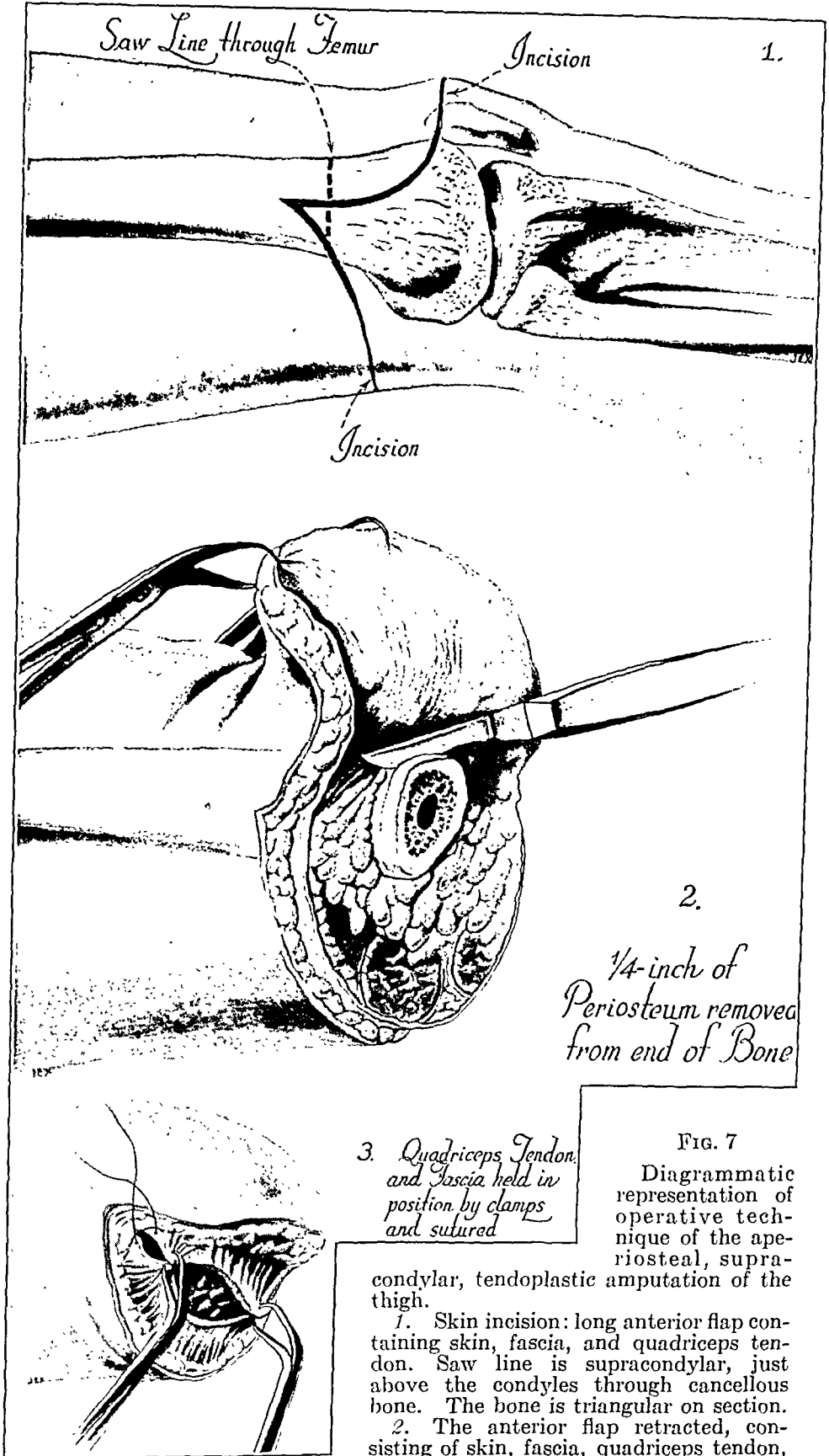


FIG. 7

Diagrammatic representation of operative technique of the aperiosteal, supra-

condylar, tendoplastic amputation of the thigh.

1. Skin incision: long anterior flap containing skin, fascia, and quadriceps tendon. Saw line is supracondylar, just above the condyles through cancellous bone. The bone is triangular on section.

2. The anterior flap retracted, consisting of skin, fascia, quadriceps tendon, and the aponeurosis of the vasti laterally

as they join the tendon. The fascia posteriorly is cut a quarter of an inch

FIG. 7. (*Continued*)

longer than the skin. A quarter-inch cuff of periosteum is removed and the bone end rounded off with a rasp.

8. The quadriceps tendon and its lateral aponeurosis are secured in their proper position to the fascia posteriorly with towel clamps until sutured. The quadriceps tendon is brought directly over the bone end. A rubber tissue drain is placed under the muscle-tendon flap.

end of the femur. When successful, it is wholly end-bearing. Its success depends upon bony union of the patella with the femur in proper position. Delayed union, tilting of the fragment, spur formation, necrosis, or infection means failure. This stump cannot be fitted with its prosthesis until bony union occurs.

The supracondylar tendoplastic operation, likewise, gives a full end-bearing stump. Success is not dependent upon bony union, which is a factor to be considered in all osteoplastic amputations, and the operative procedure is simpler and less time-consuming than the Gritti-Stokes. It is ready for fitting with its prosthesis in from five to six weeks after amputation. Wilms in 1902, after sawing through the femur, covered its end with the quadriceps extensor tendon, which he sutured to the periosteum on the posterior surface of the femur. The technique of the supracondylar tendoplastic amputation follows (Fig. 7):

This is an aperiosteal amputation through the supracondylar portion (metaphysis) of the femur. The quadriceps tendon, which is included with a long anterior skin flap, is cut close to its insertion into the patella, brought over the end of the sectioned femur, and sutured to the fascia posteriorly. The saw line is supracondylar, one to one and one-quarter inches above the upper edge of the articular cartilage on the anterior surface of the femur. The femur at this level is triangular in shape from the flare of the condyles, and is flat anteriorly. The saw line is through the cancellous bone of the condyles, below the medulla of the shaft. A tourniquet is applied around the thigh.

The skin incision to form the anterior flap begins just above the saw line in the mid-lateral long axis of the femur, extends downward, gradually swings across the anterior surface of the thigh just below the upper margin of the patella, and back up the other side of the thigh in like manner to just above the



FIG. 8

The ideal thigh stump, end-bearing, the result of a supracondylar tendoplastic aperiosteal amputation. The suture line is posterior. It is wholly weight-bearing at the end of six weeks, painless, and fitted with its prosthesis.

saw line in the mid-lateral long axis of the femur. The skin incision is now carried posteriorly with a convexity downward, so that it will retract to the saw line. The anterior incision is deepened to the bone at the edge of the retracted skin, and the quadriceps tendon cut away from the patella at its insertion into that bone. This U-shaped flap, consisting of skin, fascia, quadriceps tendon, and muscle tissue joining the tendon laterally, is now lifted up and all of the suprapatellar bursa dissected out underneath. The fascia is cut posteriorly one-quarter inch longer than the retracted skin flap. Other muscle and soft parts are cut so that they will retract to the saw line. The soft parts are gently retracted so as not to detach the periosteum. The periosteum covering the bone at the saw line is cut through circularly with a knife and the bone sawed through at right angles to the long axis of the thigh. The periosteum is cut circularly around the bone, one-quarter inch above the sawed end, and this cuff of periosteum is carefully removed, shredding being prevented. The bone end is rounded off with a rasp and the bone dust and any periosteal shreds are removed by a salt-solution flush.

The femoral vessels are isolated and doubly ligated with plain catgut. Three knots are always tied in the catgut ligature to prevent its slipping. The sciatic nerve, which at this level may have divided into the internal and external popliteal, is isolated, pulled down while the muscles are retracted, ligated with plain catgut, using a needle to transfix the sheath so that the ligature will not slip, injected with absolute alcohol above the tie, cut with a sharp knife, and allowed to retract. The tourniquet is removed and all bleeding arrested. If the flaps have been properly cut, the anterior U-shaped flap of skin, fascia, tendon, and muscle will fit snugly over the bone end, forming a suture line with the fascia and skin on the posterior surface of the thigh, throwing the suture line posterior to the bone end. The anterior fascia-tendon-muscle flap is fixed to the posterior fascia of the thigh with towel clamps to secure position until sutured. The quadriceps tendon is placed directly over the bone end. This layer is now sutured with plain catgut; chromic gut is not necessary. The skin is closed with silkworm-gut, tension-type sutures being used.

A rubber tissue drain is placed under the fascia-tendon-muscle flap posterior to the bone end. The stump is dressed with sterile gauze, bandaged tightly, and covered with gauze and cotton pads. Skin traction for a few days will relieve any redness or tenderness in the stump end that may develop due to the pull of the quadriceps tendon against the bone end.

This method gives an ideal stump, full end-bearing in all cases, symmetrical in contour, free from spurs, and of maximum functional length. The medullary canal is not opened, and the quadriceps muscle group and the tensor fasciae femoris are securely anchored. The hamstring tendons are caught in the posterior sutures. It is applicable in a complete ankylosed knee joint and requires no skin below the middle of the patella. It has proven so satisfactory that it is considered the method of choice

where a satisfactory below-knee stump cannot be obtained. Full weight-bearing has been obtained as early as three weeks after amputation (Fig. 8).

No originality is claimed for the surgical technique of the two stumps just described. These methods have been used by me since 1919 and have been found entirely satisfactory. It is not believed that their functional value when properly fitted with a prosthesis can be improved by other operative procedures.

#### SUMMARY

1. Sites of election for amputation in the lower extremity from a functional standpoint are:

The bases of the metatarsal bones in the foot.

Middle third of the leg.

Supracondylar in the thigh.

2. The surgical technique of the mid-leg amputation and of the supracondylar tendoplastic amputation is described.

3. The aperiosteal method is considered the method of choice in the closed amputation.

4. Large muscle pads over the stump end are objectionable.

Certain of these illustrations have appeared in the chapter on "Amputations", written by the author for Dean Lewis's Practice of Surgery (Vol. III, Chap. 10, 1929) and are used by the courtesy of the publisher, W. F. Prior Company, Inc., Hagerstown, Maryland.

## CERTAIN ARTHRITIC DISTURBANCES ASSOCIATED WITH PARATHYROIDISM \* †

BY ROBERT V. FUNSTEN, M.D., UNIVERSITY, VIRGINIA

*Professor of Orthopaedic Surgery, University of Virginia*

A survey of arthritic cases has been made in order to isolate those which might fit into the parathyroid group. Ninety-five cases of arthritis, chiefly of the ankylosing type, were examined. Twenty-six of these showed symptoms suggestive of parathyroidism. The development of arthritis in the presence of parathyroid disturbance is a common occurrence, and is frequently responsible for the first symptoms.

### CLINICAL DIAGNOSIS

Several cases were striking in their histories and in the ultimate findings and results. The general appearance of the patient, his prolonged history of pain, weakness, and stiffness in the joints, particularly the spine, is the outstanding clinical symptom suggesting further investigation. The pain is usually not relieved for any considerable time by orthopaedic methods.

The next most important finding is the characteristic demineralization of the spine, long bones, and skull as shown by x-ray examination. Even in the moderately advanced case there is calcium absorption in excess of the amount to be expected from disuse (Figs. 1 and 2). The roentgenograms of the skull show "granular" changes, which in the more advanced cases may even reach an appearance suggestive of Paget's disease as shown in Figures 3 and 4. In the early stages the arthritic findings in the spine may be mild as compared to the muscular weakness (Fig. 5).

Paroxysmal abdominal pains may be present. These pains are so severe in some instances that they can be relieved only by morphin. They disappear so rapidly following parathyroidectomy that they can scarcely be considered the result of mechanical irritation of the nerve roots. In one instance, a case, later diagnosed as parathyroidism, came to the clinic after having been discharged elsewhere as a morphin addict.

Although the determination of the calcium content of the blood and the calcium excretion in the urine is of considerable importance in confirming the diagnosis, still the disease in this respect simulates to some extent the picture of gout. The calcium shower into the blood is apt to be paroxysmal just as is the pain. It is often necessary to repeat the calcium determination many times for a true picture of the disease.

\* From the Orthopaedic Clinic at Harper Hospital, Detroit, Michigan.

† Presented at the Annual Meeting of the American Orthopaedic Association, Toronto, June 16, 1932.

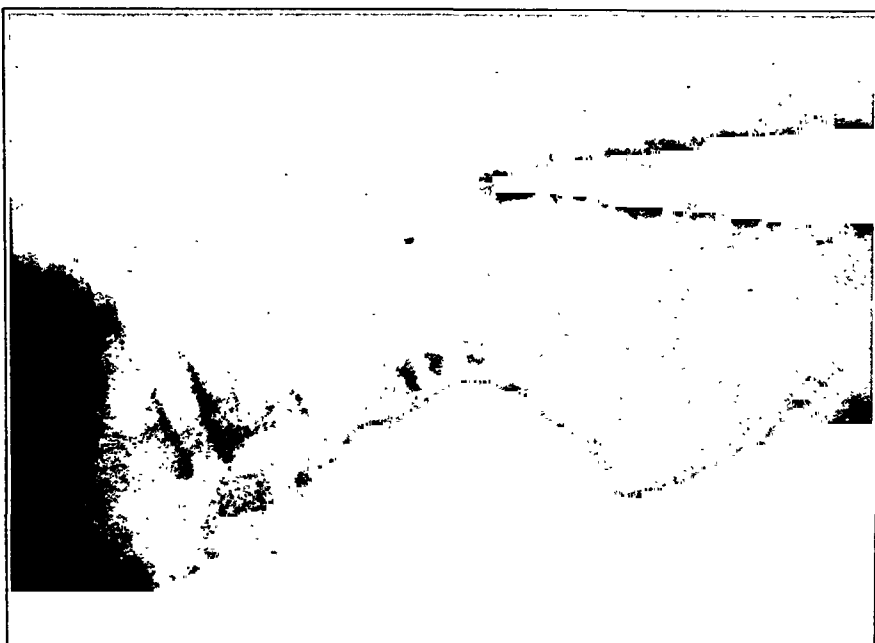


FIG. 2

Hypertrophic arthritis of the spine with atrophy characteristic of parathyroid disease.

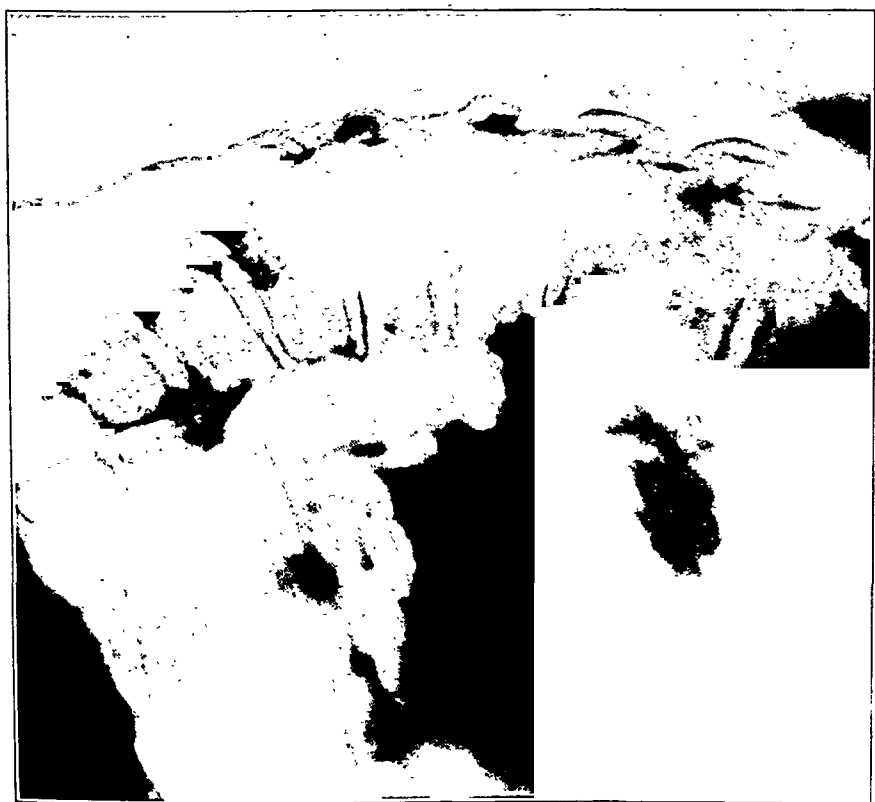


FIG. 1

Roentgenogram of a man seventy-five years of age with extensive hypertrophic changes, but little atrophy.

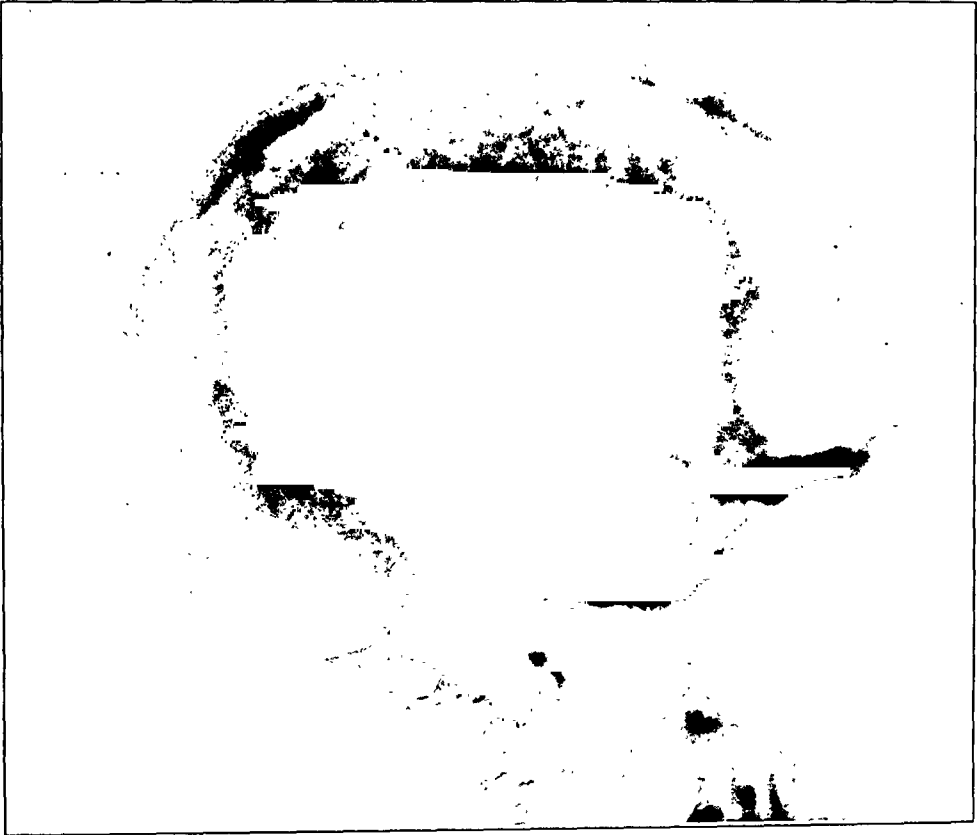


FIG. 3  
Extensive Paget's disease of skull.



FIG. 4  
Skull in moderately advanced parathyroid disease, showing granular appearance of inner table.

Most of the cases have shown a blood calcium of high normal (10.2 milligrams per 100 cubic centimeters), and in one case it reached the high point of sixteen milligrams per 100 cubic centimeters.

If the calcium intake is properly regulated, the urinary excretion of calcium is a more nearly consistent index. According to Hunter as well as Compere, a normal individual on a low calcium diet excretes about one-tenth milligram per 100 cubic centimeters in a twenty-four hour specimen, whereas, on an average calcium diet it may reach five-tenths milligrams per 100 cubic centimeters. In the parathyroid syndrome it may go as high as three times the normal amount.

Additional evidence of parathyroidism has been obtained through electrical stimulation of the muscle by means of the chronaximeter, which gives the optimum *closing cathodal-contraction* for the minimum time element. This, for the flexor of the little finger, is normally .00032, whereas, in parathyroidism the index may be .00038 or 0.0050.

In the electrocardiogram reading, as shown by Dr. E. D. Spalding of Harper Hospital, the R-T interval is shortened. This is normally .00026 to .00028 seconds. In parathyroidism it is .00022 or less.

The irregularity in finding the characteristic blood and urinary pictures has led in several instances to a delay in diagnosis, which was not reached until x-ray evidence had become conclusive in itself. The following case brought this to my attention:

William C., aged twenty-four, reported to the dispensary May 3, 1929, complaining of stiffness and pain in the back and hips. This had gradually increased for a period of two years. During treatment his tonsils and all his teeth had been removed without improvement.

Examination showed a round-shouldered individual with a marked limitation of motion and tenderness over the spine and sacro-iliac joints. Roentgenograms (Fig. 6) showed spurring of the lower lumbar segments, diminution of the disc between the fourth and fifth lumbar vertebrae, and obliteration of the sacro-iliac joints as well as the articular facets.

No calcium determination was made until December 1930, nineteen months after admission. Three determinations showed practically a normal calcium metabolism. The basal metabolism was minus twelve.

In the meantime, he developed more severe pain, limitation of motion, and muscle spasm in the left hip. A plaster spica was applied. This at first gave almost complete relief, but after a few weeks had to be removed because of increasing pain. He was again admitted to the hospital in January 1931. At that time his spine and hips had stiffened to such an extent that it was necessary for him to sleep in a sitting position.



FIG. 5

Characteristic rounding of shoulders in parathyroid arthritis.



Every source of infection was investigated without any positive findings. Lumbar ganglionectomy was performed by Dr. Frederick Schreiber for relief of the pain. Patient was considerably improved for about three months and was able to walk several blocks on crutches without much pain. However, pain of a paroxysmal character recurred and he was readmitted to the hospital in December 1931. At that time the blood calcium was as high as twelve milligrams and the phosphorus as low as two and six-tenths milligrams. The chronaxia was slightly above normal. Roentgenograms then showed marked demineralization of the dorsal and lumbar spine with reduction of the size of several of the dorsal vertebrae. The arthritis had progressed. The skull had a "granular" appearance. Two parathyroid bodies were removed on December 16, 1931, by Dr. Ballin. These showed adenomatous changes. Within forty-eight hours after operation, motion was freer in the joints and pain was considerably relieved. The calcium gradually returned to normal. After six months, roentgenograms showed an increase in the calcium content of the spine and arrest of the progress of the arthritis. An instance of the misappropriation of calcium was noted in this case. A calcified mass developed in the parotid gland which was expressed after several attacks of swelling.

Another case, Mrs. R. M., aged fifty-seven, complained of severe backache for four years, unrelieved by orthopaedic treatment. Roentgenograms showed thinning of the intervertebral discs, the ankylosing type of arthritis, and general demineralization (Fig. 7). The blood calcium ran as high as fourteen and six-tenths milligrams and phosphorus



FIG. 6

Lateral view of arthritic spine, showing characteristic demineralization.

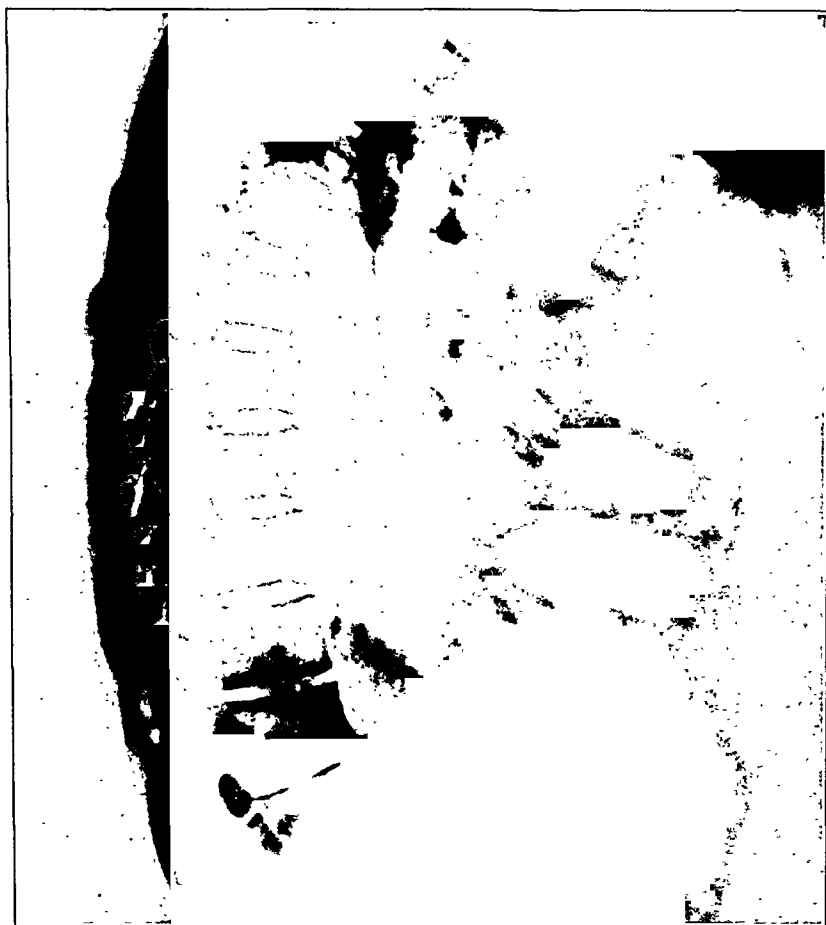


FIG. 7

Roentgenogram showing hypertrophic arthritis in the presence of extensive demineralization.

two and ninety-five hundredths milligrams. Two adenomatous parathyroids were removed on February 9, 1931, by Dr. Ballin and almost immediate relief of pain was experienced. This has continued until the present time.

A typical case of spondylitis connected with parathyroid disease is shown in that of Mrs. R. McA., aged twenty-six. She has always been round-shouldered, possibly as a result of early epiphysitis, but developed severe pain and stiffening of her spine following pregnancy (Fig. 8). She was treated by conservative orthopaedic methods for several months without relief. Roentgenograms showed a mild generalized spondylitis with narrowing of the bodies of the sixth, seventh, and eighth dorsal vertebrae and thinning of the intervertebral discs. Two parathyroids were removed by Dr. Ballin on May 18, 1931. Following this, there has been complete relief of backache which has continued to the present time. Because of the severe deformity, she was placed on a hyperextension Bradford frame, with great improvement of the deformity.

In several of the cases there has been a removal of part or all of the thyroid in addition to parathyroid tissue. Since there has been a considerable amount of discussion as to the rôle of these two glands

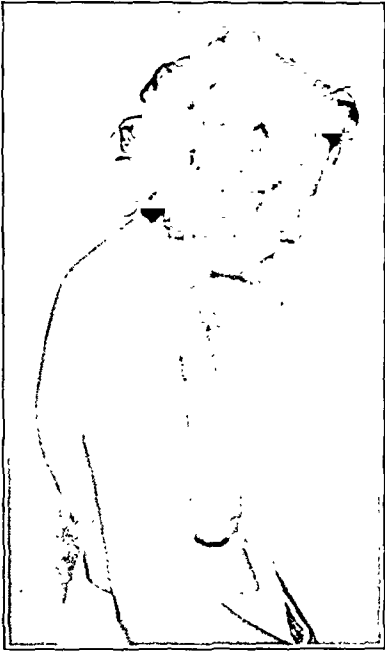


FIG. 8

Typical posture in parathyroid arthritis.

in the production of arthritis, it seems well to point out one case in our clinic in which the parathyroid syndrome manifested itself in a moderately high blood calcium, ankylosing arthritis of the spine and hips, and a calcification of the femoral trochanteric bursa. This patient left the clinic and went to another hospital where an adenomatous thyroid gland was removed without any improvement in symptoms. She did not get the rapid relief of pain and the sense of relaxation in the joints, which seems to be characteristic of parathyroidectomy.

Parathyroidectomy was done in fourteen of the twenty-six cases. Only one of the cases operated upon failed to show improvement. This young woman had cervical arthritis with radiculitis.

Nine cases showed marked improvement. Within a day or two following operation, the sensation of stiffness in the joints began to disappear and there was less pain and more ease of motion. They were classified as markedly improved only when entirely free from pain and when the roentgenograms showed an increased density in the bones. Four cases were moderately improved.

The shortest postoperative observation was four months. The longest period of observation has been eighteen months.

Twelve cases were treated conservatively with cod-liver oil concentrate, calcium gluconate, physiotherapy, and orthopaedic appliances. Of these, five were much improved, three were moderately improved, and four showed no improvement.

#### CONCLUSIONS

1. Arthritis is very common in parathyroid disease.
2. Parathyroid disease is frequent in arthritis, either as a primary cause or secondarily as the result of a common etiological factor. It may be recognized by symptoms of paroxysmal pain in the spine and abdomen, deformity of the spine, and x-ray evidence of demineralization.
3. The diagnosis may be substantiated by means of repeated blood and urine calcium determinations and chronaxia.
4. There is almost immediate relief of pain and a feeling of relaxation in the joints following parathyroidectomy.
5. In the milder cases, when it is not possible to make an absolute diagnosis and in poor surgical risks, treatment by means of cod-liver oil concentrate and calcium gluconate accompanied by conservative ortho-

paedie treatment may lead to improvement and arrest of the disease, at least temporarily.

6. The operations for the removal of the parathyroids, all of which have been performed by Dr. Ballin, have not been accompanied in any instance by tetany or shock, and can be considered sufficiently harmless to justify the procedure in even the milder cases.

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## PARATHYROIDISM IN REFERENCE TO ORTHOPAEDIC SURGERY\*

BY MAX BALLIN, M.D., DETROIT, MICHIGAN

Parathyroidism due to hyperplastic or adenomatous conditions of the parathyroid glands has become a recognized entity. Its main symptoms are an elevated serum calcium with some decrease in the serum phosphorus, increased calcium and phosphorus output in urine and feces, larger than the intake, and, therefore, a negative calcium and phosphorus balance. It is of the utmost importance to understand that this surplus of calcium in serum and excretions under the influence of increased parathyroidal function is taken from the skeleton; therefore, decalcification of the bones, osteoporosis and late retrogressive changes, osteitis fibrosa cystica, bone cysts, osteoclastic processes, giant-cell tumors, deformities, and pathological fractures of the softened bones are sequelae of increased parathyroid function,—that is, parathyroidism. These are all facts now verified by ample clinical observations, by the cure of the conditions accomplished by removal of the hyperplastic or adenomatous parathyroids, and by the experimental production of the same features mentioned through injections of parathyroid extract. The skeleton is the main organ affected by parathyroidism. (We have used in our writings the shorter word, parathyroidism, instead of hyperparathyroidism as it covers just as much.) For this reason the subject is of paramount importance to the orthopaedic surgeon. Nevertheless, besides the skeletal changes, the upset in calcium and phosphorus metabolism also causes gastro-intestinal and urinary symptoms, metastatic calcium deposits, and muscular hypotonia. While these latter symptoms are not of direct importance to orthopaedic work, they are worth mentioning for diagnostic purposes and clinical understanding.

The connection between parathyroidism and skeletal changes was brought out first by the frequent autopsied findings of skeletal changes with parathyroid tumors. Erdheim<sup>1</sup> and Barr, Bulger and Dixon<sup>2</sup> have collected forty-five such cases, and we know of a few more, where osteomalacic conditions, especially osteitis fibrosa cystica, if looked for, were nearly always found together with hyperplasias or adenomas of the parathyroid.

Numerous experiments have now been made, showing that repeated injections or overdoses of parathormone will produce decalcification of the skeleton, typical osteitis fibrosa cystica with osteoclastic processes and giant-cell formation, hypercalcinuria, intestinal upsets, great muscular weakness, and, in poisonous doses, death from these symptoms. These same conditions we see in human beings suffering from para-

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FIG. 1

H. J. B., sixty-three years old. Compression of vertebral. Was diagnosed metastatic malignancy. Calcium 14 milligrams. Parathyroidectomy brought complete relief. Outline of vertebral body retouched. Lived two years in comfort. Died from uraemic condition. Nephritis preceded parathyroidectomy and was due to hypercalcaemia.



FIG. 2

R. C., fifty-six years old. Practically the same symptoms, diagnosed myeloma in this case. Had to use codoin for pain. Note compressed vertebral at arrow.

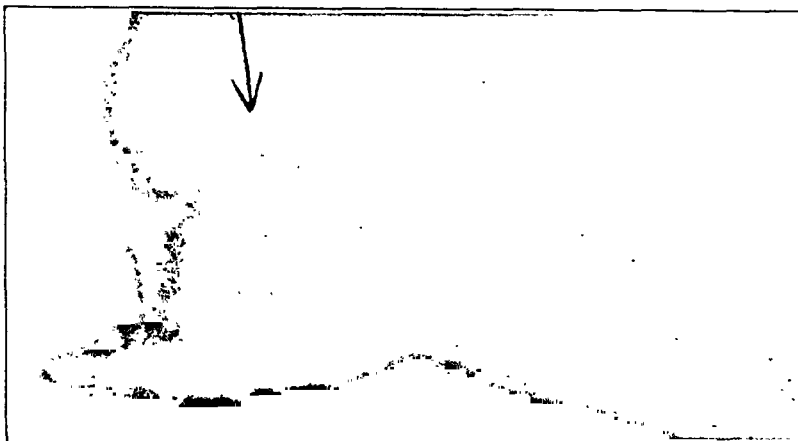


FIG. 3

Same case as Fig. 2, nearly one year after parathyroidectomy. Clinically cured eighteen months after operation. Note compressed vertebral at arrow.



FIG. 4

M. R., female, forty-nine years old. Diagnosed compression fracture of lumbar vertebrae. Six months later entered Harper Hospital in ambulance in excruciating pain; could hardly move; showed several such compressed vertebrae. Calcium 14 milligrams. Removal of parathyroid adenoma gave complete relief.

the sudden disturbance of parathyroid function. In our own forty-five cases, up to date we have not had a fatality. The results of operation we will take up in going over the different types of the disease of interest to the orthopaedic surgeon.

We distinguish the following types:

1. The vertebral form, mainly expressed by kyphosis and compressed vertebrae, usually slow in progress.
2. The infantile type, usually more rapid.
3. The arthritic type.
4. The Paget type.
5. Types where muscular hypotonia or gastro-intestinal symptoms are more prominent than the skeletal.

All five groups overlap each other and cannot be strictly separated.

thyroidism (Collip<sup>3</sup>, Wilder<sup>4</sup>, Jaffe and Bodansky<sup>5</sup>). Very recently J. L. Johnson<sup>6</sup> has published a most interesting paper, showing beautiful examples of such osteitis fibrosa cystica artificially produced in dogs. He comes to the conclusion: "This experimental disease, produced with repeated injections of parathormone, is characterized by skeletal lesions and other abnormalities which correspond closely to those observed in clinical cases of osteitis fibrosa osteoplastica (von Recklinghausen)".

About the clinical observation, we were able to collect from the literature and from our own recent experiences 100 cases of parathyroidectomies followed, except for a few surgical mortalities, with good results in every case in which the parathyroids or parathyroid tumors were removed. In a few of the 100 cases parathyroids were not found; four patients died, three of these from postoperative tetany. These deaths are practically all avoidable under the methods we have since learned, consisting of proper technique in leaving one or, better, two functioning parathyroids, and proper postoperative care in preventing

People of all ages seem to be subject to the disease. It is surprising in looking over the tabulations we made of these 100 cases to note in how many cases the disease started early in life, in some even in infancy. The vertebral form in mid-life seems to be the most frequent one unless it be the arthritic form, of which Dr. Funsten has spoken to you, and which will receive the attention and recognition it deserves.

1. The vertebral type, as we call it, usually begins with back-leg ache. We use this expression as Hunter<sup>7</sup> writes that this sickness seems to be very frequent in China and goes under the name of back-leg ache. This fact brings the disease to the attention of the orthopaedic surgeon and in our experience there is hardly a case that is not first diagnosed lumbago, sciatica, or, if the attending physician has orthopaedic inclinations, the diagnosis may be more refined,—sacro-iliac or intervertebral arthritis,



FIG. 5

J. B., female, sixty-one years old. Compressed vertebrae, expansion of nucleus pulposus causing cupping of vertebral bodies. Severe pain. Clinical relief of pain by parathyroidectomy.

disturbance of the nucleus pulposus in the intervertebral discs, and so forth. As the disease progresses, the pain increases and the x-ray shows the apparent kyphosis manifested by wedging of the vertebrae, loss of lime in the vertebrae, and pathological fractures of the vertebral bodies. The first two of our cases at this stage of the affection, when they needed codein and morphin for their pain, were diagnosed metastatic malignancy,—the first one of unknown origin, the second as malignant myeloma. To be sure, the differential diagnosis of metastatic malignancy at times is quite difficult, especially in cases of prostatic carcinoma if the primary cancer is not evident; but one ought to become suspicious that there is no malignancy if the patient lives one, two, or three years without coming to the customary ending of metastatic malignancy. This was really the only reason that in our first two cases the diagnosis was finally changed, and the patients were given relief by the removal of parathyroid tumors (See Figures 1, 2, and 3).

In three other cases of the vertebral type a diagnosis of fracture was





FIG. 6

E. P., fourteen years old. Juvenile form. Note extreme deformities and scars of bed sores showing how sick this girl was from her hypercalcaemia, multiple fractures, and osteomalacic process.\*

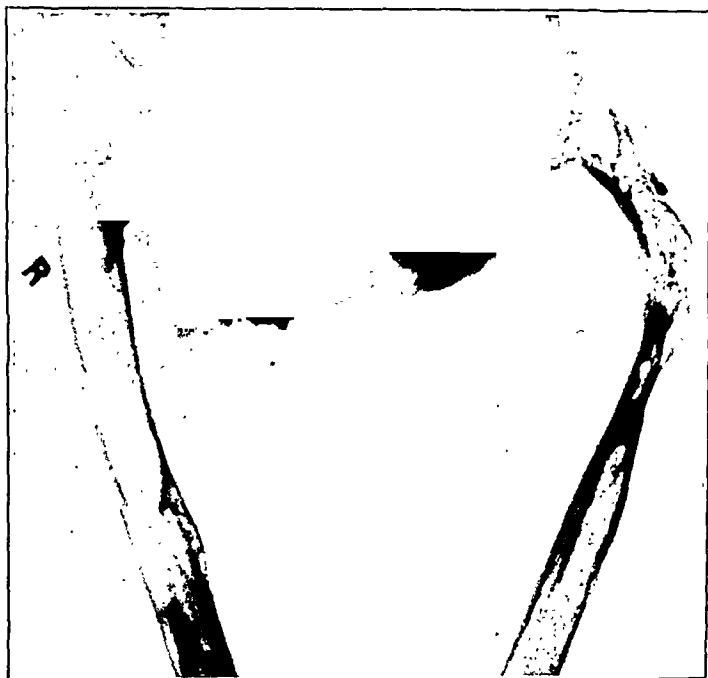


FIG. 7

Shows roentgenogram of same patient before removal of parathyroid adenoma. Great decalcification of pelvic bones and cysts in both femora. Pathological fractures through left upper femur. This type of femur is rather characteristic of the juvenile type with coxa vara.

made; one patient was placed in a plaster-of-Paris corset, another was advised that he should have a bone graft or some other stabilizing operation to support the broken vertebra. These details are given for the sake of bringing out the importance of proper diagnosis. One of these patients had in childhood, ten years previous to the slight accident that led to the compression fracture of the vertebrae, an operation on the neck of the femur, some mass being removed without getting a good diagnosis; in the light of our present knowledge, no doubt this was some cystic mass. These findings should have called attention to the fact that there must be a general skeletal disease that caused the disease in the femur and the fracture. In a second case the fracture happened from such a minute cause that, without malignancy being present, there should have been enough reason to go over the whole skeleton for a general affection. When these two cases came under our care, each had extensive lesions in the spine, skull, and other bones, high serum calcium, low serum phosphorus, pronounced hypotonia of the muscles as shown in muscle tests and electrocardiogram; so that the diagnosis could not be doubted. The lesson to be gained from this is that any compression fracture of the spine acquired without undue violence should, in our day, be an indication for studying the blood chemistry and taking a general roentgenological survey

\* Case illustrated in Figures 6, 7, and 8 was operated upon by Dr. Grover C. Penberthy of Harper Hospital.



FIG. 8

Roentgenogram of same patient after parathyroidectomy. Note recalcification of pelvic bones, return of outline of all bones shown, and recalcification of the subtrochanteric fracture.

of the skeleton, especially of the whole spine and skull. The skull shows the changes very early (Fig. 4).

There is another type of older person who gets shorter and bends over; such patients are usually placed in the group of senile spondylarthrititis or senile kyphosis, but their pain is so excruciating and their muscular weakness becomes so prominent that they become bedridden invalids. In this group the same diagnostic survey as to blood chemistry and skeleton should be made. We have operated upon at least six patients between the ages of sixty and seventy years, who were bedridden and needed opiates for their pain, and brought them back to a livable existence without pain. We should not call conditions senile and be satisfied with this diagnosis; if the majority of human beings do not have such symptoms of senility, it is logical that there must be some other special reason for this suffering besides age. A parathyroidectomy is not a dangerous operation; in the future it will be still less so and is worth considering if it can make the evening of a life free from pain (Fig. 5).

2. Much more difficult is the question of the infantile skeletal lesions and their connection with parathyroidism. There is one group which usually develops very rapidly, begins with general intestinal and urinary symptoms, followed quickly by skeletal pains and deformities. The x-ray shows general decalcification, cyst formations, and osteoclasias



FIG. 9

E. B. Smaller child of the same type as Fig. 6, five years old. Same coxa vara. Note shortening of right femur.



FIG. 10

Same patient. Subtrochanteric fracture of left thigh, causing great shortening of left leg.

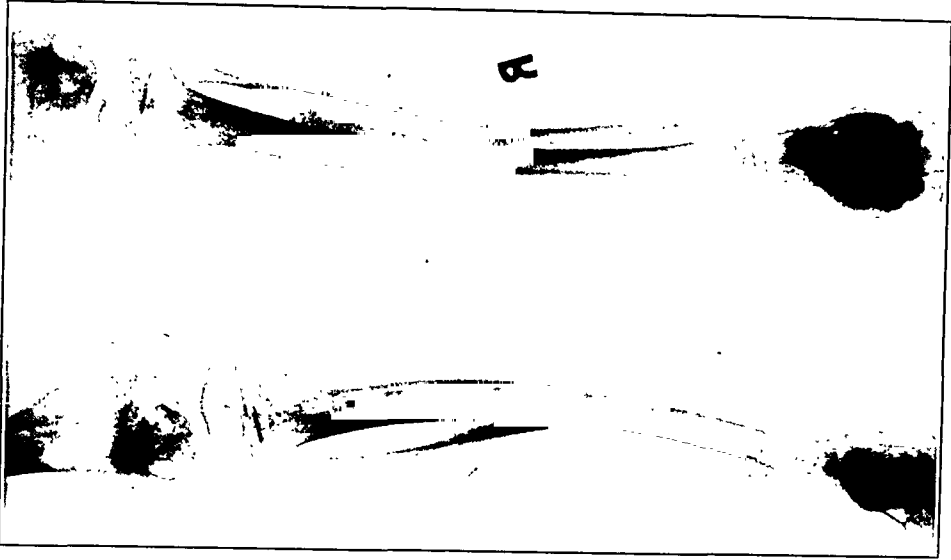


FIG. 11

Lower legs of same patient. Note curving of the bones.

(Giant-cell tumors is the report if they are biopsied); multiple fractures occur, such as have been described by Hunter<sup>8</sup>, Quick and Hunsberger<sup>9</sup>, and others. These cases should be operated upon early to avoid the frightful deformities which later can only be arrested but perhaps not overcome by orthopaedic care following parathyroidectomy. Three such cases have been exarticulated in the hip joint, presumably for osteosarcoma (Beck<sup>10</sup>); in the last one, described by Gordon-Taylor and Wiles<sup>11</sup>, a similar tumor developed in the other leg; cure followed removal of a parathyroid tumor. The author very candidly states that when the leg was amputated he did not know of the entity of parathyroidism. Surely, if three courageous men have reported such mishappenings, it is a logical conclusion that it has happened much oftener without being reported. The possibility of parathyroidism is also a reason for biopsy before amputation, in spite of warnings from eminent pathologists. A malignant osteosarcoma that is fatal anyway will not do much more harm if biopsied, and the protection of the patient against amputation of a limb should logically be the deciding factor for biopsy of such tumors.

Quick and Hunsberger's case, a young adolescent who shrunk from four to five inches with the most grotesque deformities of all his limbs, was first reported as multiple giant-cell sarcoma until the right diagnosis and parathyroidectomy led to the beginning of his cure. This case is mentioned to bring out the fact that giant-cell sarcoma is not a neoplasm, but a reaction of osseous tissue to certain factors, in this case decalcification, and is curable by parathyroidectomy.

At present we have under our care a young boy, fourteen years old, who has a little slower type of the disease, but with wide-spread cystic degeneration of the bones and three fractures so far. We have no doubt that parathyroidectomy will provide recalcification and union of the last fracture which has not yet shown any callus formation after several weeks. His roentgenograms are so striking that one is given here (Fig. 19\*). Another case seen in consultation with Dr. Grover C. Penberthy is of the same group (Figs. 6, 7 and 8).

In smaller children the many different names given to the seemingly local symptoms of a general process are very misleading and probably need a check-up and a new nomenclature. We have five cases of undoubted parathyroidism, as proven by the blood chemistry and the roentgenograms, in which cystic processes developed around the upper end of the femora, leading to fractures—subtro-

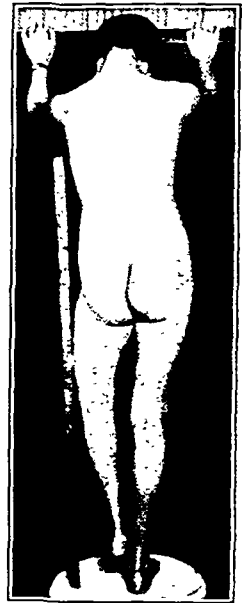


FIG. 12

B. N. Child, now twelve years old, suffering from what was diagnosed as enchondroma for eight years. Note again the typical shortening of one leg in these juvenile forms, called by Shallow "arrested type".

\* For a special reason explained in the legend, this figure is given last.

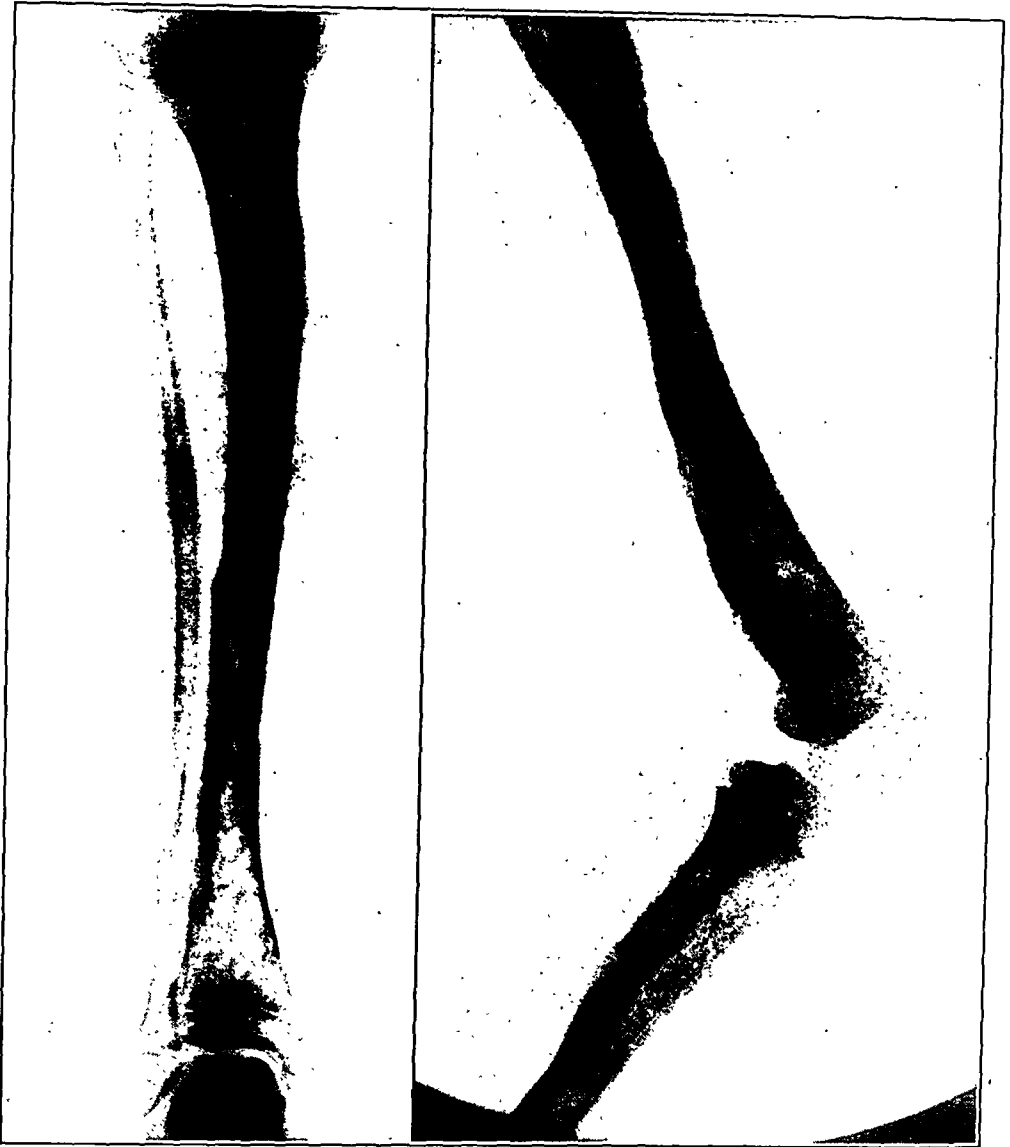


FIG. 13

Shows multiple fractures in tibia. Last fracture occurred at age of eleven years.

FIG. 14

Shows deformity of the femur and tibia.

chanteric usually—and extreme coxa vara, caused by the weight of the body on the decalcified necks of the femora, and in which one leg grew much shorter than the other (three to four inches difference); also three cases in which one arm became shortened for the same reason. If the fibrocystic process encroaches on the epiphyseal lines, it is easy to understand that we find in the bones cysts, besides giant cells, chondromatous tissue arising from the epiphyseal cartilage; and, therefore, a good many of them are diagnosed chondromata. Slipping epiphysis is another name used for the disturbance (See Figures 9–15). The results of parathyroidectomy in four of these cases, while most of them have only been observed for a short time (one, however, for more than sixteen months), are so encouraging that parathyroidectomy may be recommended early.

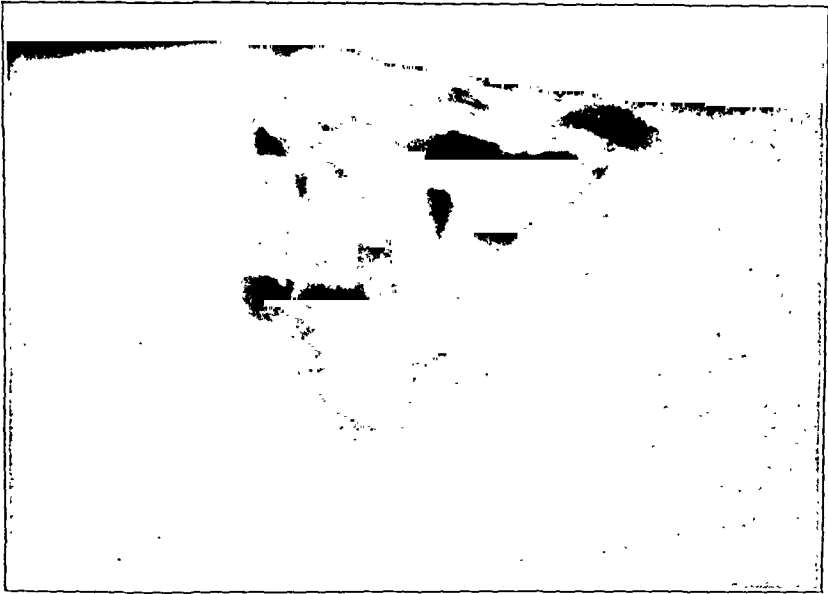


FIG. 16

Mr. T. Shows the spine, rather resembling osteitis fibrosa cystica with its compressed vertebrae. (See Fig. 17.)

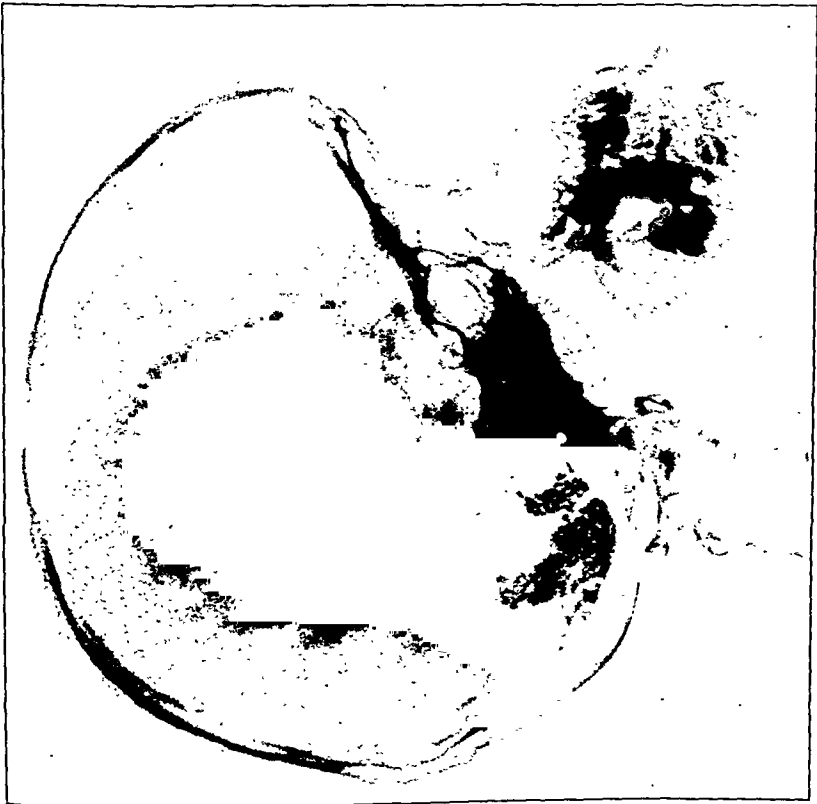


FIG. 15

Skull of same case again gives proof of the general nature of the decalcification by granular mottling, etc.

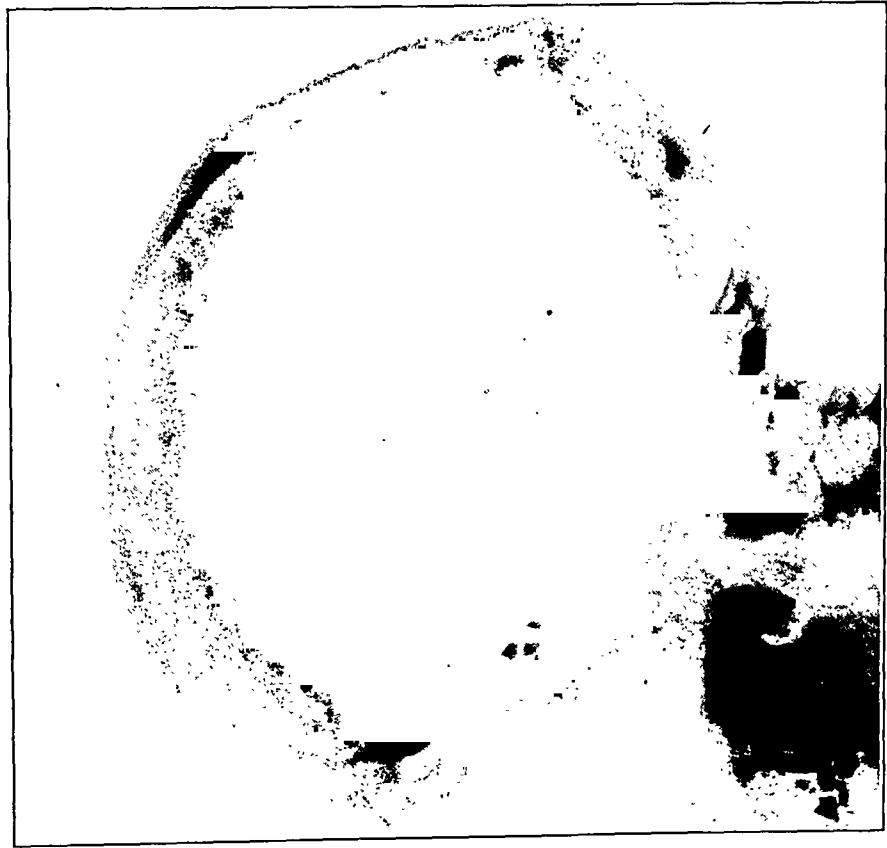


FIG. 17

Mr. T. Typical Paget's skull with great thickening. Hard of hearing. Head size increased two full sizes. Stature shrunk three inches. Severe pain and asthenia.

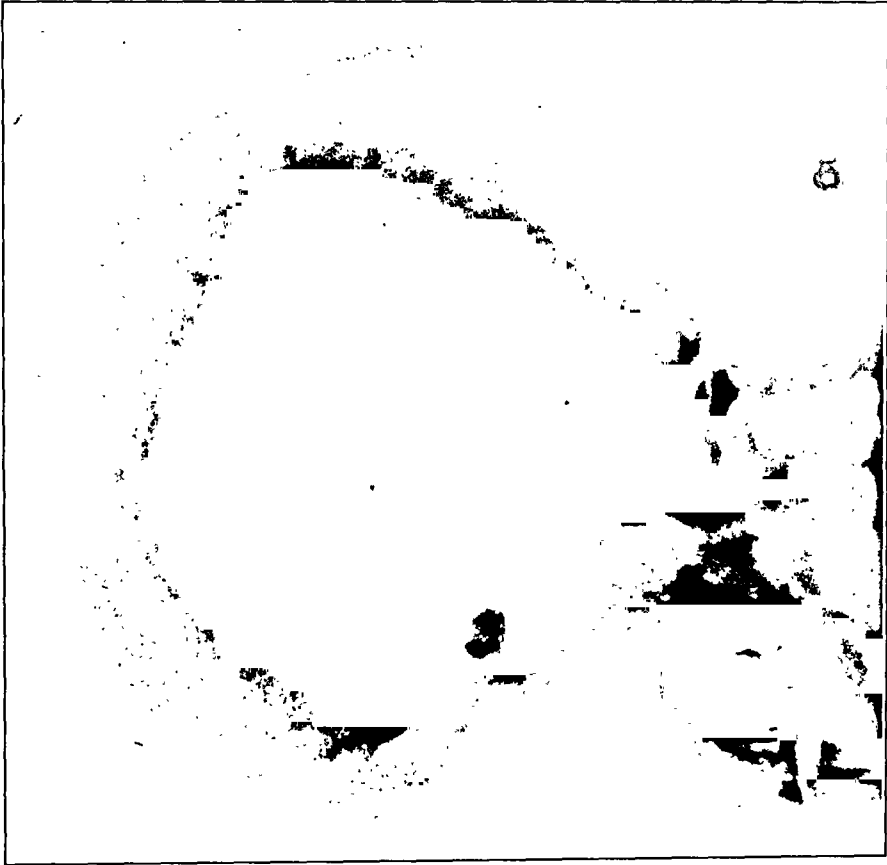


FIG. 18

Same skull as Fig. 17 six months after removal of two parathyroids. Note the much clearer outline of the parieto-occipital region, fuzziness of the outer table disappearing, hearing improved. Stature is erect again, has regained one and one-quarter inches in height, and can walk several miles without discomfort. Before operation 100 yards would tire him out.

Moreau<sup>12</sup> maintains that all the conditions showing decalcification and disturbed calcium metabolism as main symptoms are controlled by endocrine disturbance, chiefly of the parathyroid. Many orthopaedic men have emphasized this fact in discussing the different forms of epiphysitis and arthritis (Kidner<sup>13</sup> and Pemberton<sup>14</sup>). Moreau, however, goes further in claiming that "it does not make much difference whether repeated trauma or a microbic agent is a contributing factor, the pathogenetic endocrine factor is the important one; without this the injury or the mild infection would not produce the peculiar phenomena of the faulty calcium distribution and this may be local or general". Moreau also mentions that "under this 'intriguing hypothesis', besides the osteopoicilia and marble bones, would come many similar conditions,—melorheostosis (Leri, 'candle-drip' hyperostosis of bones), Paget's disease, hypophyseal dysostosis or Schüller-Christian syndrome, leontiasis ossea, hyperostotic lumbarthria, calcification of the nucleus pulposus, Kümmell's disease, Sicard's disease, Putti's disease, etc., etc.". It is pleasing that in our work on these conditions, Paget's disease, leontiasis ossea, and the calcifications in the nucleus pulposus have already been included in the group of parathyroidism (Ballin and Morse).<sup>15</sup> To be sure, it will require observation for a few years more, especially on the results of parathyroidectomy in these children, to ascertain what really belongs to parathyroidism. The clinical

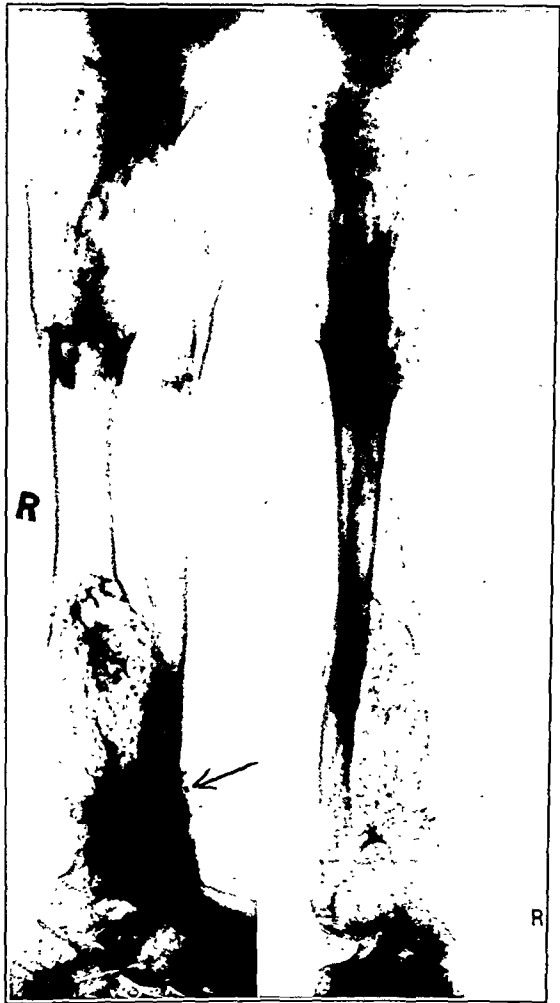


FIG. 19

G. P., boy, fourteen years old, with multiple fractures at the age of three. Multiple osteoclastomata in practically all bones of hands, toes, etc. This roentgenogram is shown on account of the simultaneous existence of osteopoicilia and osteitis fibrosa cystica at arrow. Osteopoicilia and marble bones have been considered by some to be of parathyroid origin, which this picture perhaps confirms.



test as to whether these little patients can be benefited by parathyroidectomy will be the final deciding factor.

3. The arthritic form which Dr. Robert Funsten has discussed (See page 112) should receive careful attention. Parathyroidism has its distinctive place as to origin and so forth in a selected group of arthritis cases.

4. A few words about Paget's disease. I will not go into the long-standing dispute as to whether osteitis fibrosa cystica (von Recklinghausen) and osteitis deformans (Paget) are two different entities or not. Pathologically, microscopically, and clinically we find transitory stages from one to the other. The incidence of sarcoma in Paget's disease is also not a distinguishing factor. But now the results of parathyroidectomies in Paget's disease confirm the opinion that the two diseases are identical and can be controlled by parathyroidectomy. We have published elsewhere the results of Shouten<sup>16</sup>, Boevé<sup>17</sup>, Chifoliau, Léri and Weill<sup>18</sup>, Sainton, and others in cases where the symptoms were mixed in the same patient; these patients usually had Paget skulls or femora and osteitis fibrosa cystica in arms and spines. Both types of symptoms improved after parathyroidectomy. Of the true Paget type we have operated on three cases,—one, seemingly, a monostatic Paget's disease of the femur in which, however, a general survey of the skeleton by roentgen ray showed other decalcifying lesions; the second and third typical Paget's disease with thickened skulls and so forth, in which parathyroidectomy showed immediate improvement as to pain, the hyperostotic fuzzy outline of the skull disappearing and a clearer outline of the external table becoming apparent. In the first of these cases the indistinct, thickened outline of the femur, within two months after the operation, showed a clear outline of the marrow cavity and the cortical substance (Figs. 16, 17, and 18). The French, who have given a good deal of consideration to this question of Paget's disease, have come to the conclusion that one should explore the parathyroid region to ascertain as to whether the case is a Recklinghausen's disease or a Paget's disease (Sainton<sup>19</sup>).

5. A few cases of parathyroidism will express themselves mainly in gastro-intestinal symptoms (Pemberton and Geddie<sup>20</sup>); in others the muscular weakness is outstanding. The weakness of the movements of these patients resembles a pseudohypertrophy of the muscles. Frequent falls occur on account of the hypotonia, the legs giving way. Often such patients come to the orthopaedic surgeon for severe backache. In most of these cases a thorough study of the muscular reaction and of the blood chemistry will lead to the right diagnosis and some splendid cures have been effected by parathyroidectomy. Four methods are in vogue for diagnosing the muscular hypotonia:

a. The determination of the milliamperes needed to provoke the muscular contraction (Oppel<sup>21</sup>).

b. The finer method of determination of chronaxia,—that is, bringing in the time factor of the muscular contraction (Bourguignon<sup>22</sup>).

c. The moving picture will show the slow and weak action of the muscles (Rowntree<sup>23</sup>) and allow comparison preoperatively and postoperatively.

d. The electrocardiogram shows that the muscular weakness does not spare even the heart muscle, this being proven by the shortening of the R. T. interval.

It is not possible here to go into the details of these methods which have been described elsewhere (Edward D. Spalding<sup>24</sup>, Ballin and Morse).

In a few cases the muscular atony is accompanied by coldness and bluish color of the limbs and this has led to ganglionectomies for suspected Raynaud's disease. Pressure on cranial nerves by the softened and deformed Paget skull, or on the spinal root and the cord in the case of osteitis fibrosa cystica of the spine, has led to diagnoses of cerebral affections or spinal tumors. We know of three such cases where a parathyroidectomy should have been done instead of ganglionectomy or laminectomy. Sainton calls all the forms mentioned under this last section "*formes frustes*" of parathyroidism.

A few conclusions of our studies are:

1. The knowledge acquired in the study of parathyroidism makes it necessary for physician and surgeon to pay much more attention to blood chemistry as far as calcium and phosphorus are concerned, and not to limit roentgen-ray examinations to one painful spot if there is even a suspicion of a general skeletal affection. Intractable back-leg aches, curving of the spine, shortening of the stature, multiple fractures, pathological fractures not explained by metastatic malignancy, bone cysts, giant-cell tumors,—all should demand the study of the patient for the presence of parathyroidism.

2. While osteitis fibrosa cystica is the main skeletal affection caused by parathyroidism, Paget's disease and certain forms of arthritis with some calcium disturbance, muscular hypotonia, indigestion with vomiting, dysuria with high serum calcium,—all should be studied carefully as to the parathyroid factor.

3. Besides the parathyroid, the thyroid, Cushing's syndrome in certain adenomata of the anterior lobe of the pituitary gland, and other rarer endocrine disorders may show skeletal disturbances, but probably a parathyroid factor is present in all these types.

4. As to treatment, a trial with the well known therapy for rickets and osteomalacia—sunlight, ultraviolet rays, irradiated cod-liver oil, and calcium preparations—is worth while; transitory forms from rickets with only compensatory hyperplasia of the parathyroids to real parathyroidism, also mild types of the latter may yield to such treatment. Rapidly progressive cases of parathyroidism and exacerbations after temporary remissions should be operated upon before permanent deformities of the skeleton or serious damage, especially to the kidneys, supervene.

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NOTE: Much of the important information presented at the Annual Meeting of the American Orthopaedic Association at Toronto in the discussion of the subject of parathyroidism has been incorporated in the following papers by Dr. Bauer, Dr. Compere, and Dr. Nachlas. These observers, who have been interested in laboratory studies and investigation of this subject, are presenting in their communications some of the results of their work in this field.—*Editor*.

## HYPERPARATHYROIDISM: A DISTINCT DISEASE ENTITY \*†

BY WALTER BAUER, M.D., BOSTON, MASSACHUSETTS

An adequate description of a previously unrecognized disease is frequently necessary in order to establish the fact that it is not a rarity. Such has been our experience with the disease called hyperparathyroidism or generalized osteitis fibrosa cystica (von Recklinghausen<sup>1</sup>), as shown by the large number of cases reported during the six years that have elapsed since the first cases were recognized clinically<sup>2, 3</sup>. If sufficient interest is aroused concerning this disease, perhaps more of the earlier cases will be detected and parathyroidectomy performed before the permanent bone changes and complications have occurred. But what is of even more interest at this time is whether or not other skeletal diseases are due to hyperparathyroidism. Certain workers<sup>4, 5, 6, 7, 8, 9, 10, 11, 12, 13</sup> have suggested that other skeletal diseases,—namely, certain cases of arthritis and Paget's disease—are due to hyperparathyroidism. If such skeletal diseases are due to hyperparathyroidism, then the cause and the cure of two previously obscure diseases have been discovered. Personally, I do not believe we have sufficient data to prove that either of these diseases is due to an increased secretion of the parathyroid hormone. Therefore, I do not think we are justified in advising parathyroidectomy in other than proven cases of generalized osteitis fibrosa cystica. My reasons for making these statements are:

Hyperparathyroidism or generalized osteitis fibrosa cystica is a clear-cut, distinct disease entity caused by an increased secretion of the parathyroid hormone. This disease was first recognized clinically by Mandl<sup>2</sup> in Vienna and by DuBois<sup>3</sup> in America. All cases thus far reported have been due to a parathyroid adenoma. The fact that it is a disease of endocrine origin implies that the entire skeleton is affected. Arthritis and Paget's disease are never generalized skeletal diseases. This fact alone argues against their being of parathyroid origin. Hyperparathyroidism is a disease characterized by definite alterations in the calcium and phosphorus metabolism as well as by certain symptoms and signs. The alterations in the calcium and phosphorus metabolism are:

\* From the Medical Clinic of the Massachusetts General Hospital.

† This is publication Number 11 of the Robert W. Lovett Memorial for the study of crippling disease, Harvard Medical School, Boston, Massachusetts.

1. *An Elevated Serum Calcium.* Serum calcium values as high as twenty-three and six-tenths milligrams per 100 cubic centimeters have been reported<sup>14</sup>. The normal serum calcium varies between nine and five-tenths and ten and five-tenths milligrams.
  2. *A Decreased Serum Phosphorus.* Values as low as one and four-tenths milligrams per 100 cubic centimeters have been observed<sup>3</sup>, in contrast to normal values of four to five milligrams.
  3. *An Increased Calcium Excretion.* The increased excretion of calcium is entirely urinary, the fecal excretion being unaffected.
  4. *An Increased Phosphorus Excretion.* The increased excretion of phosphorus is also entirely urinary.
- The increased excretions of calcium and phosphorus in one reported case were of the same magnitude as those in a normal individual receiving 100 units of an active parathyroid extract per day<sup>3</sup>.

These alterations in the calcium and phosphorus metabolism may be accompanied by any or all of the following symptoms and signs:

1. Polydipsia.
2. Polyuria.
3. Weakness and loss of strength.
4. Constipation.
5. Loss of appetite.
6. Loss of weight.
7. Indefinite muscle and joint aches and pains (commonly diagnosed rheumatism, arthritis, or neuritis).
8. Bone tenderness.
9. Frequent fractures, often following slight trauma.
10. Decreased excitability of the nerves.
11. Skeletal shortening.
12. Kyphosis.
13. Bone tumors, frequently diagnosed epulis of the jaw or giant-cell tumor in other bones.
14. Kidney or ureteral stones (usually bilateral).
15. Characteristic x-ray findings,—such as, generalized decalcification, bone tumors, multiple bone cysts, fish-type vertebral bodies, etc.
16. Frequently anaemia with leukopenia.

In view of the above facts, I do not believe any patient should be subjected to a parathyroidectomy until sufficient evidence has been gathered from the history, physical examination, roentgen examination and metabolism studies to leave no doubt as to the correctness of the diagnosis of hyperparathyroidism. Until some simple test for hyperparathyroidism is devised, all suspected or questionable cases of hyperparathyroidism should be very carefully studied. Serum calcium and serum phosphorus determinations should be made and, if possible, serum phosphatase as

well as total calcium and phosphorus metabolism studies. It certainly behooves us all to proceed cautiously before making or accepting any statement which implies that certain cases of arthritis are due to hyperparathyroidism or that Paget's disease is of parathyroid origin.

Oppel<sup>3</sup> first reported favorable results in cases of spondylitis deformans (Strümpell-Marie type) following parathyroidectomy. Later Leriche<sup>4,5</sup> and others<sup>6,7,9</sup> reported similar results in cases of ankylosing polyarthritis. Funsten<sup>10</sup> stated that certain of his cases had been operated upon by Dr. Ballin with very gratifying results. The arguments which have been advanced that certain cases of arthritis are due to hyperparathyroidism are: (1) that some of these cases have a definitely increased serum calcium, and (2) that the ankylosis observed is a manifestation of the disease. No one of these observers present metabolism studies showing that the previously mentioned alterations in the calcium and phosphorus metabolism were present, nor do they present sufficient data pertaining to the history, physical examination, or roentgen examinations to enable one to make such a diagnosis. One must further remember that metastatic calcification is a very late manifestation of the disease and occurs only in fatal cases or in animals which have succumbed to overdoses of parathormone.

Dr. Funsten stated that in suspected cases one should do repeated serum calcium determinations. By doing so, one will obtain one or two serum calcium values which are distinctly elevated, thus enabling one to make a diagnosis of hyperparathyroidism. All cases of hyperparathyroidism, which we have observed, have had a permanently elevated serum calcium and not transitory elevations such as reported by Dr. Funsten. We usually ascribe transitory elevations in serum calcium as due to a failure to obtain a fasting blood sample, and, if this has not been the case, we always raise the question of whether or not there has been any error in technique. It must be remembered that a serum calcium determination tells one only the height of the calcium stream and not its direction of flow into the bones or into the excretory channels. If one realizes this fact, he can understand the need of doing total calcium and phosphorus metabolism studies in any suspected or questionable case.

I, personally, have never seen any findings in patients with either form of arthritis that would suggest the existence of hyperparathyroidism as a causal factor. True, many of the cases of rheumatoid arthritis show x-ray evidence of decalcification (bone atrophy). However, this is no more than we often see associated with disuse. Furthermore, we know that the calcium excretion of a patient when immobilized in a cast is much higher than when this same patient is allowed ordinary ward activity. To date, we have studied the total calcium and phosphorus metabolism of a series of cases, some of them having rheumatoid or proliferative arthritis, others having hypertrophic or degenerative arthritis. We took particular pains to see that we had chosen cases of rheumatoid or proliferative arthritis that showed marked bone atrophy and cases of degenerative

or hypertrophic arthritis showing marked proliferative bone changes. As a result of these studies, we can state that we found no changes in the serum calcium or serum phosphorus or the calcium and phosphorus metabolism of a degree sufficient to enable one to make a diagnosis of hyperparathyroidism. The alterations in the calcium and phosphorus metabolism observed were hardly any more marked than one obtains in a study of a large series of normal individuals observed on the same régime.

The improvement reported in cases following parathyroidectomy may have been due to anaesthesia, rest in bed, or a natural remission of the disease. These three factors are all capable of bringing about improvement, particularly in cases of rheumatoid arthritis. Because the latter disease is characterized by remissions and relapses, improvement is often ascribed to a particular form of therapy, whereas in reality it may represent nothing more than a natural remission.

Another reason why I am skeptical about arthritis occurring as a result of hyperparathyroidism is the fact that in the last five years at the Massachusetts General Hospital the two diseases have never been observed in the same patient, although seven cases of hyperparathyroidism have been studied.\* All seven cases have satisfied all the requirements necessary to make such a diagnosis; all cases have been operated upon and in each instance a parathyroid tumor was found; yet no one of them had arthritis.

One patient has been known to have had the disease for thirteen years. This patient, a sea captain, was first recognized as a case of hyperparathyroidism by Dr. Eugene F. DuBois in 1926<sup>3</sup>. He has suffered from eight fractures. He has a marked kyphosis, considerable skeletal shortening, and permanent bone deformities. His serum calcium has ranged between thirteen and one-tenth and sixteen and five-tenths milligrams per 100 cubic centimeters as compared to normal values of nine and five-tenths to ten and five-tenths milligrams. The serum phosphorus varied from one and four-tenths to three and two-tenths milligrams per 100 cubic centimeters. The calcium and phosphorus excretions were markedly elevated. He was operated upon by Dr. E. P. Richardson<sup>15</sup> in May, 1926, and June, 1926. At each operation a parathyroid gland was removed, normal in appearance, but microscopic examination showed fatty infiltration. Removal of these two glands did not result in a cure, and the serum calcium and phosphorus, as well as the total calcium and phosphorus metabolism studies, remained unchanged. Despite a high calcium diet his symptoms and signs increased to such an extent that a third search was made for a parathyroid tumor in March, 1932, by Dr. Russel H. Patterson of New York City, but again no tumor was found. He was again transferred to the Massachusetts General Hospital in May, 1932. Examination at this time showed considerable increase in the severity of his disease. The decalcification had increased; there were

\* Six of these cases were thoroughly studied by Dr. Fuller Albright. Detailed reports concerning these cases will be published by him in the near future. I am indebted to Dr. Albright for having seen these patients.

many more bone cysts; questionable calcification of the kidney cortex, demonstrable on flat x-ray plate of the abdomen; kidney and ureteral stones; hypercalcaemia and hypophosphataemia. Kidney function tests showed marked renal impairment evidenced by a non-protein nitrogen of sixty milligrams per 100 cubic centimeters and a phensulphophthalein excretion of ten per cent. in two hours' time. At three subsequent operations by Dr. Oliver Cope and Dr. E. D. Churchill, careful dissections of the various regions of the neck between the angles of the jaw and upper mediastinum were made; yet no parathyroid tumor or tissue was found. On November 2, 1932, an anterior mediastinotomy was done by Dr. E. D. Churchill. The parathyroid tumor, encased in a calcified capsule, was found; ninety per cent. of it was excised, the remainder of the tumor was turned up on its pedicle and sewed in a superficial position in the region of the sternal notch. The serum calcium fell rapidly, and signs of tetany appeared on the third day. At this writing the serum calcium continues to fluctuate between four and five-tenths and seven and two-tenths milligrams.

Therefore, this patient not only had the disease for thirteen years, but also suffered from permanent bone deformities and the complications of hyperparathyroidism; yet there was no evidence of arthritis.

Ballin<sup>11</sup> and Ballin and Morse<sup>12, 13</sup> have stated that Paget's disease is likewise due to hyperparathyroidism. I cannot agree with this statement, as the signs and symptoms of the two diseases are not the same. There are many differences when one compares Paget's disease with hyperparathyroidism. Many of the differences were stressed by the late Prof. Schmorl<sup>16</sup> in an exhaustive pathological study of the largest group of cases of Paget's disease ever reported. Paget's disease occurs in older people, usually males, and is regularly associated with marked arteriosclerosis, whereas hyperparathyroidism is met with in all age groups, more commonly in females, and arteriosclerosis is not a common finding. Malignant bone tumors develop in a fair number of the cases of Paget's disease; such is rarely, if ever, observed in hyperparathyroidism. Fractures (frequently spontaneous) occur very often in hyperparathyroidism and seldom in Paget's disease. Renal calculi are the exception in Paget's disease but are very often found in hyperparathyroidism. In Paget's disease, the changes are sometimes confined to one lone bone and, as Schmorl points out, the entire skeletal system is never involved. However, in hyperparathyroidism, a disease of endocrine origin, the effect is a generalized one, every bone of the body being involved. Although gross examination does not always reveal the generalized nature of the disease, microscopic examination does. The bones in Paget's disease are soft, often bowed, and a thickened cortex is demonstrable on both x-ray and macroscopic examination. In hyperparathyroidism, x-ray examination shows bones with thinned cortices and bone cysts. In the gross, one observes thinning of the cortices, bone cysts, and the brown tumors described by von Recklinghausen. It is true that histological bone sections



from these two diseases may be similar and therefore it may be difficult to make a diagnosis on this basis alone, even though the histological features of these two diseases are usually characteristic.

Turning to the calcium and phosphorus metabolism studies, one finds very little to support the theory that Paget's disease is due to hyperparathyroidism. A high serum phosphatase is present in both, but is much more marked in Paget's disease. However, it should be remembered that an elevation in serum phosphatase occurs in other bone conditions. In collaboration with Doctors Aub, Albright, and Marble<sup>17</sup> the author has studied the calcium and phosphorus metabolism in seven cases of Paget's disease. These patients represented the early and late stages of the disease. They also represented various ages. No one of this series or other cases (on whom no metabolism studies were carried out) showed any elevation of the serum calcium or lowering of the serum phosphorus. In two of the cases thoroughly studied, the calcium and phosphorus excretions were slightly increased, but the increased excretions were not confined solely to the urine as they are in cases of hyperparathyroidism.

Because of his inability to demonstrate the presence of parathyroid tumors in his large series of cases, Schmorl concluded that Paget's disease was not due to hyperparathyroidism. He found no more enlargement of the parathyroid glands in Paget's disease than under normal conditions. In discussing its etiology, he presents certain evidence that the observed pathology might best be explained on a vascular basis. He further suggests that stress and strain may well play a rôle in bringing about the bone changes. In support of this theory he shows that the bones subjected to the most stress and strain are most frequently involved.

Ballin and Morse believe that the improvement observed following parathyroidectomy supports their theory that the disease is of parathyroid origin. Their cases had not been followed for a sufficiently long period of time to state definitely that lasting benefit or a cure had been obtained. The operation and rest in bed may have been responsible for the improvement reported. The author has observed patients who reported considerable improvement when made to adhere to a high calcium, high vitamin diet and regular rest periods. Furthermore, in the natural course of Paget's disease there may be periods during which the patient may complain of very few symptoms.

Until we have sufficient evidence to prove that Paget's disease and certain cases of arthritis are due to hyperparathyroidism, I believe there is no justification in advising parathyroidectomy in patients with either disease.

#### CONCLUSIONS

1. Hyperparathyroidism, a generalized skeletal disease, is a distinct disease entity due to a parathyroid adenoma. It is characterized by definite alterations in the calcium and phosphorus metabolism, symptoms, and signs. These findings have been presented as concisely as possible.

2. Data have been presented showing that arthritis is not associated with or due to hyperparathyroidism.

3. Paget's disease is not a generalized skeletal disease as is generalized osteitis fibrosa cystica. This fact, as well as certain clinical and metabolic data, clearly demonstrates that Paget's disease is not due to hyperparathyroidism.

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# THE RÔLE OF THE PARATHYROID GLANDS IN DISEASES ASSOCIATED WITH DEMINERALIZATION OF THE HUMAN SKELETON \*

BY EDWARD L. COMPERE, M.D., CHICAGO, ILLINOIS

Hyperparathyroidism, usually associated with an adenomatous tumor of one or more of the parathyroid glands, has been established as the etiological factor in the production of generalized osteitis fibrosa, a very chronic disease which progresses with pain, fractures, and disabling deformities, and may be fatal. There is generalized demineralization of the bones of the skeleton, and multiple foci of osteitis fibrosa, with or without benign giant-celled tumors, and cysts are common. It is a disease entity different from local osteitis fibrosa, osteitis deformans, osteogenesis imperfecta, osteomalacia, rickets, and ankylosing polyarthritis. The similarity between the roentgen-ray studies of some of the conditions in this group is well known, and the most experienced pathologist may at times find it difficult to differentiate between the gross or microscopic picture of bone affected by von Recklinghausen's disease and a section of bone from a case of Paget's disease. The clinical picture of several of the abnormal skeletal conditions mentioned may be very similar to that of generalized osteitis fibrosa (von Recklinghausen's disease). But while clinically, roentgenologically, and pathologically similar, there is a difference in the biochemical manifestations of these diseases as demonstrated in studies of the mineral metabolism.

The mere recognition of osteoporosis of the human skeleton associated with hypotonia and decreased irritability of the muscles to electrical stimuli, with or without an elevation of the serum calcium, is too little evidence upon which to base a diagnosis of overfunction of the parathyroid glands. The presence of enlarged parathyroid glands, in the absence of a negative calcium balance, or at least a reduced calcium balance, is not sufficient evidence to justify their removal. Hyperplasia of the parathyroid glands may be a purely compensatory enlargement in response to a demand of the organism as a result of a deficiency of calcium absorption from the bowel. This has been demonstrated clinically in cases of deficiency diseases, such as osteomalacia and rickets, by Hoffheinz<sup>1</sup> and Erdheim<sup>2</sup> and in studies of experimentally produced rickets by Pappenheimer and Minor<sup>3</sup>, Doyle<sup>4</sup>, Nonidez and Goodale<sup>5</sup>, Higgins, Foster and Sheard<sup>6</sup>, Erdheim<sup>7</sup>, and Luce<sup>8</sup>. Some of the parathyroid glands became ten times as large as normal and the microscopic sections revealed benign hyperplasia similar to that described by Ballin and Morse<sup>9</sup> in enlarged glands removed from patients suffering from ankylosing polyarthritis. Treatment of the rickets with diet and

\* From the Division of Orthopaedic Surgery, Department of Surgery, The University of Chicago.

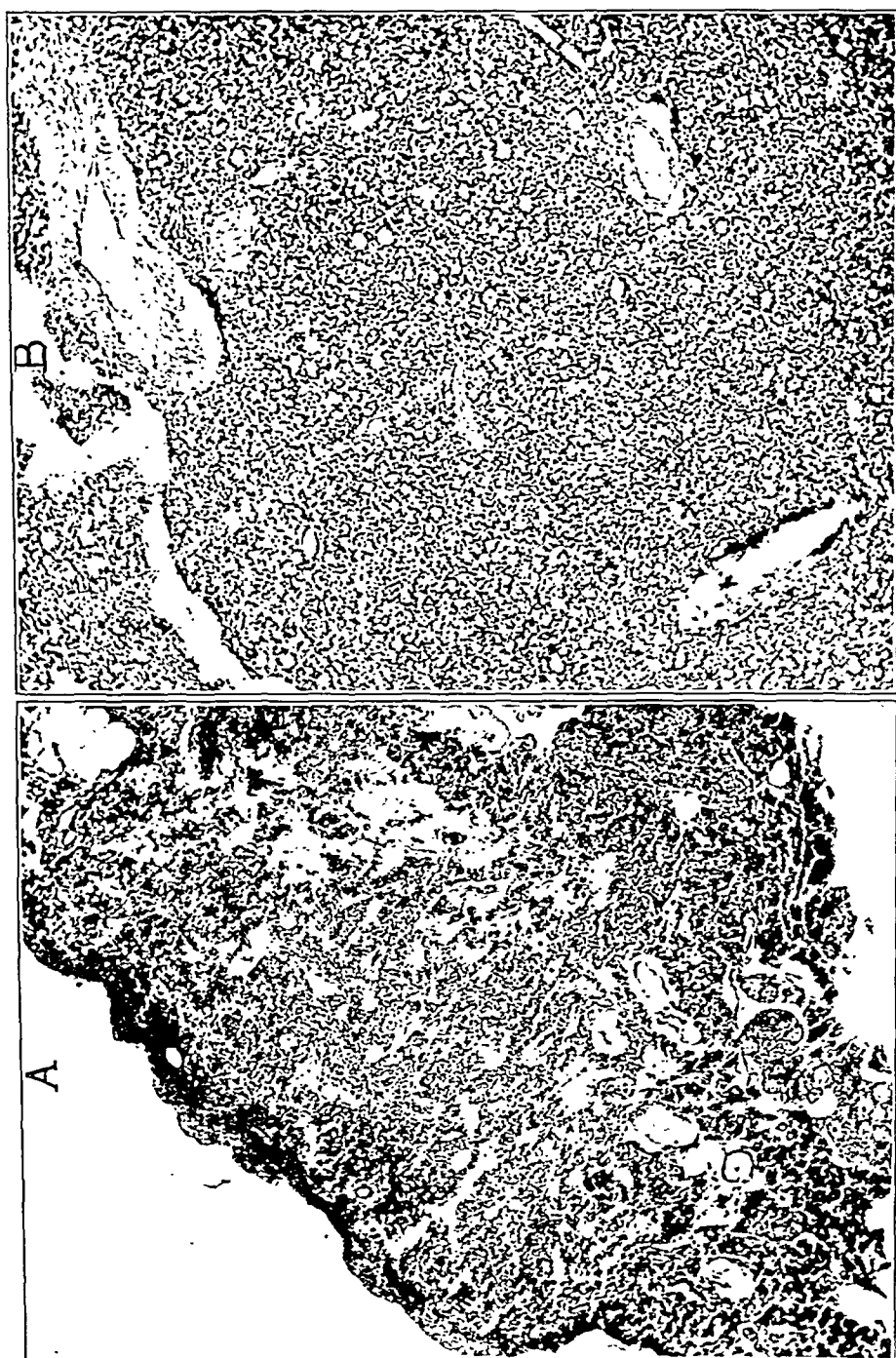


FIG. 1

A. Normal parathyroid gland cell structure and arrangement similar to that of enlarged glands removed from patients with ankylosing polyarthrits.  $\times 70$ .

B. Adenoma of parathyroid gland typical of the tumors found in cases of von Recklinghausen's generalized osteitis fibrosa. See Table II for comparison of microscopic pictures.  $\times 70$ .

TABLE I

MICROPATHOLOGY OF THE PARATHYROID GLANDS	
<i>Normal Gland or Benign Hyperplasia, Typical of Those Reported in Rickets, Osteomalacia, Metastatic Osteoplastic Carcinoma, and Ankylosing Polyarthrititis.</i>	<i>Adenoma of the Parathyroid Gland Typical of That Reported in More Than Forty Cases of Generalized Osteitis Fibrosa Cystica of von Recklinghausen.</i>
Cellular elements may be diffuse or compact	Cellular elements very compact
Definite arrangement of irregular strands or trabeculae	Less connective tissue and no strand-like arrangement of cells
Occasional acinus	Numerous acini
Many fat cells	Few or no fat cells
Many foam cells	No foam cells
Few granules in nuclei	Large dark-staining granules in nuclei of cells

vitamin D resulted in decrease in the size of the parathyroid tumors. Since these tumors were produced on a deficiency diet and were found to recede when the deficiency was corrected, the hyperplasia in this condition was obviously compensatory (Fig. 1 and Table I).

Oppel<sup>10</sup>, Ssamarin<sup>11</sup>, Leriche and Jung<sup>12</sup>, Ballin<sup>13</sup> and Funsten<sup>14</sup>, have reported clinical improvement in cases of ankylosing polyarthrititis following parathyroidectomy. A review of the description of the microscopic studies as well as of the photomicrographs published has failed to demonstrate a true adenoma of one or more of the parathyroid glands in these series. Enlargements of the glands in some cases were reported, but the cell picture was that of simple hyperplasia. Those who have reported these studies have accepted the clinical syndrome of generalized demineralization of bones, hypotonia of the muscles, and lengthening of the chronaxia with an increase in the serum calcium, as sufficient evidence to make a diagnosis of "parathyroidism". Ballin and Morse also state that "hypercalcaemia can be temporarily or continuously absent, and if so should not exclude the diagnosis of parathyroidism if all other symptoms speak for it". The most definite and pathognomonic finding in true hyperparathyroidism due to an adenomatous tumor is that of a negative calcium balance, but Bauer<sup>16</sup> and his associates have found that every case of ankylosing polyarthrititis in their series was in positive calcium balance. No reports are published by the authors who advocate parathyroidectomy in ankylosing polyarthrititis to show their results in studies of metabolism of calcium and phosphorus.

Leriche and Jung reported the serum calcium slightly elevated in only three of twenty cases of ankylosing polyarthrititis which they studied. Parathyroidectomy was attempted in each of these cases. Marked symptomatic improvement was reported for the first case, but six months after the operation the patient had suffered a relapse and was worse than

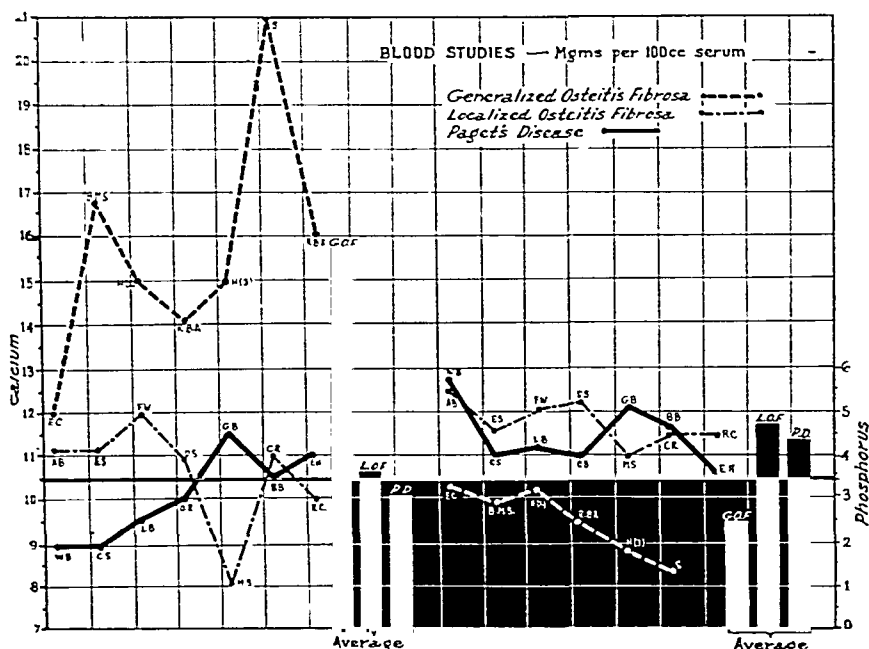


CHART I

The striking contrast between the calcium and phosphorus content of the blood serum in true hyperparathyroidism due to a parathyroid adenoma and osteitis deformans (Paget's disease) is well illustrated in this graph. The average of the blood serum calcium in seven cases of generalized osteitis fibrosa (G.O.F.) is almost twice that in seven cases of localized osteitis fibrosa (L.O.F.) or Paget's disease (P.D.), while the ratio of phosphorus in the serum in the three conditions is reversed.

at the time of the first admission. The authors at this time tried the injection of parathyroid extract intramuscularly in this patient and again reported improvement. In the second and third cases there was also improvement, but the pathologist was not able to find any parathyroid tissue in the specimen removed from the second case. Apparently the improvement here was just as marked as in the cases where the parathyroid tissue was definitely excised.

In a number of the cases studied by Ssamarin and operated upon by Oppel, no parathyroid tissue was found in the specimen removed. The fact that these patients showed improvement comparable to the cases from which the glands were removed indicates that some other factor must have accounted for this change. Welti<sup>15</sup> and Bauer<sup>16</sup> agree with us that there is not sufficient evidence to show that in any case of ankylosing arthritis there was also a true hyperparathyroidism, although some of the symptoms of this condition may be found. Furthermore, the fact that ankylosing polyarthritis was not noted in any of the more than fifty cases of generalized osteitis fibrosa which have been reported, in which very high serum calcium and low serum phosphorus were found and a parathyroid adenoma was removed at operation or postmortem examination, is certainly significant. Bodansky, Blair and Jaffe<sup>17</sup> and Johnson<sup>18</sup>

TABLE II  
DIFFERENTIAL DIAGNOSIS OF CONDITIONS CHARACTERIZED BY DEMINERALIZATION OF THE BONES

Disease	Osteoporosis	1. Cysts 2. Giant-cell tumor	Pathological Fractures	Muscles	Chronicity	Pain	Characteristic Arthritic Changes	Serum		Urine Ca	Balance Ca	Sulphur Retention	Parathyroid Glands	
								Ca	P				Adenoma	Hyperplasia
Osteitis fibrosa cystica, generalized (von Recklinghausen's disease)	Generalized	1. Common 2. Common	And compression of vertebral bodies, common.	Hypotonia	Lengthened	In spine or long bones of lower extremities	None	High	Low	*** Increase	*** —	*** + balance	*** Tumor of one or two	*** Remaining usually normal in size and microscopic findings
Osteitis deformans (Paget's disease)	Hyperostosis	1. Yes 2. None	Less common	Hypotonia	Lengthened	In long bones or spine	None	Normal or below	Normal or above	Decrease	+	— balance (loss)	No definite or true adenoma reported in an accepted case of Paget's disease	All usually normal
Ankylosing polyarthritis	Generalized	1. None 2. None	Uncommon. Compression of vertebral bodies, common.	Hypotonia	Lengthened	In long bones or spine	Calcification of paravertebral ligaments above with ankylosis of the joint	Occasionally above normal	Normal	Normal	+	+ balance	No true adenoma	All parathyroid glands may be enlarged, with normal cell structure. (Probably compensatory.)
Osteomalacia	Generalized	1. Common 2. Common	Occasional. Bending common.	Hypotonia (occasional tetany).	Shortened or normal in low Ca type	In long bones or spine	None	Low	Low	Normal or below	— (low Ca intake)	Not definitely established	Found in few instances of high Ca type	All glands frequently enlarged (reported at autopsy)
Rickets	Generalized	1. Occasional cyst-like areas	Occasional	Hypotonia. Tetany occurs rarely.	Shortened or normal in low Ca type	Not common	None	Low	Low	Low	+	Not constant	Very rare	Common (compensatory)
Osteogenesis imperfecta	Generalized	1. None 2. None	Very common	Hypotonia	Lengthened or normal	Not characteristic	None	Normal	Normal	Normal	+	Not reported	None	Reported in three cases
Osteitis fibrosa localized and regional	Normal bone density except in focal or regional areas	1. Local, usually in focal solitary	Common at site of lesion.	Normal	Normal	At site of lesion only	None	Normal	Normal	Normal	+	Normal	None	None reported

\*\*\* Findings which are of pathognomonic significance in the diagnosis of generalized osteitis fibrosa.

Table II. This comparison of the skeletal dystrophies which are characterized by demineralization of the bones reveals some points of similarity, but the most significant and diagnostic evidence of the presence of an adenomatous tumor of one or more of the parathyroid glands—namely, a high serum calcium accompanied by a low serum phosphorus, marked increase in output of calcium in the urine, *negative calcium balance*—and the gross and microscopic evidence of a true adenoma of one or more of the parathyroid glands are noted consistently only in cases of generalized osteitis fibrosa.

produced typical generalized osteitis fibrosa in experimental animals by injecting parathyroid extract, but none of these animals developed arthritis.

In Paget's disease the calcium metabolism as demonstrated in our own series and also by Hunter<sup>19</sup>, Rabinowitch<sup>20</sup>, Van Hazel and Andrews<sup>21</sup> and DaCosta, Funk, Bergeim and Hawk<sup>22</sup>, is usually one of marked positive balance with a greatly diminished excretion of calcium by the kidneys. Improvement has been noted following administration of parathormone. Erdheim<sup>23</sup> found no tumors of the parathyroid glands removed at autopsy from patients with Paget's disease. Gold<sup>24</sup> reported the pathological studies of Maresch who made postmortem examinations of the parathyroid glands of forty cases of Paget's disease and was not successful in finding a parathyroid tumor in the entire series. Excision of parathyroid glands from patients who are afflicted with osteitis deformans may be as serious an error as thyroidectomy in cases of myxoedema. Zimmer<sup>25</sup> has reported cure of a case by injection of parathyroid extract.

A case of marked Paget's disease, of twenty years' standing, recently came to autopsy in this clinic and complete pathological studies were made. The parathyroid glands were entirely normal.

In Table II, I have attempted to compare several of the clinical syndromes which are characterized by local or general demineralization of the skeleton. There is some evidence that ankylosing polyarthritis may be a deficiency disease similar to rickets or osteomalacia. The typical micro-pathology of the enlarged parathyroid glands in all three conditions is that of simple hyperplasia and may be a compensatory change. The success of Fletcher<sup>26</sup> in treating multiple arthritis by means of diets, rich in vitamin and mineral content, lends support to this theory.

As I have previously shown<sup>27</sup>, "there is little evidence to indicate—and it would be difficult to rationalize the finding if it were so reported—that localized bone lesions of the bone cyst and giant-cell tumor type, without any general skeletal involvement, could be explained on a metabolic basis". The secretions of the endocrine glands must be distributed to all parts of the body and any marked effect which they may exert upon the tissues should be manifested uniformly and not locally or regionally. Experience has demonstrated that these localized lesions will heal following local excision and curettage or roentgen-ray therapy, and this further discredits the theory of an endocrine etiology.

*Chronaxia* has been defined by Ballin<sup>9</sup> as "an electric time coefficient of neuromuscular excitability defined as a minimal time in which current must pass through a muscle or nerve in order to elicit a reaction". It is not a specific test for parathyroid hyperfunction. Most conditions associated with weakness and general physical debility may give a similar delayed response. Mere fatigue in a perfectly normal individual will greatly alter the chronaxia determinations.

Too much emphasis has been laid upon the elevation of serum calcium in certain of these conditions and the equally significant plasma inorganic



phosphate determinations have not been made. The only definite test for parathyroid gland hyperfunction, which is acceptable, is the calcium metabolism study and the demonstration of a negative calcium balance. With the corresponding patients studied on a maintenance diet with basal requirements of calcium and phosphorus and also vitamin D in all of the seven types of skeletal dystrophies listed in Table II, there would be a positive balance *except* in generalized osteitis fibrosa, in which the balance is consistently negative; the serum calcium is high; the plasma phosphates are low; and true adenomata of one or two of the parathyroid glands are found in nearly all cases at operation or postmortem examination.<sup>28</sup>

Excision of a true adenomatous tumor of a parathyroid gland has resulted in relief from symptoms or improvement in each case. Churchill<sup>29</sup> has supplied further evidence to support the belief that in all cases of true hyperparathyroidism an adenoma of a parathyroid gland is present.

#### SUMMARY

Generalized osteitis fibrosa may be differentiated from other skeletal dystrophies which are clinically similar. This condition is characterized by a high serum calcium content, low plasma phosphates, increased excretion of calcium in the urine, and negative calcium balance; an *adenomatous* tumor of one or more parathyroid glands has always been found at postmortem examination and nearly always at operation, while the remaining glands are normal in size and structure.

There is no good evidence that Paget's disease is caused by hyperparathyroidism. In this condition the calcium and inorganic phosphate content of the blood are normal; the calcium balance in the chronic phase of the disease is markedly positive; the output of urinary calcium is greatly decreased; and the parathyroid glands are usually found to be entirely normal in size and in microscopic structure.

Ankylosing polyarthritis is probably not caused by hyperparathyroidism because, in this condition, although the serum calcium may be slightly above normal, the inorganic phosphates of the plasma are normal; the calcium balance is positive; the parathyroid glands have been reported enlarged, but usually this enlargement was symmetrical, involving all of the parathyroids similar to that reported in cases of rickets or low calcium osteomalacia. In experimental animals the addition of vitamin D and of adequate calcium and phosphorus to the diet will result in decrease in size of the enlarged parathyroid glands as well as healing of the skeletal disease.

Parathyroidectomy in cases of ankylosing polyarthritis or of Paget's disease is not a justifiable procedure unless there is more adequate evidence of parathyroid gland pathology than has been presented in reports of cases in the literature.

Demineralization of the skeleton in polyarthritis may be accounted for as atrophy of disuse.

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# CONSIDERATIONS ON THE USE OF PARATHYROIDECTOMY FOR ARTHRITIS

BY I. WILLIAM NACHLAS, M.D., BALTIMORE, MARYLAND

Parathyroidectomy has been performed for the cure of arthritis and favorable results have been reported in some patients. Arthritis is so widespread, the suffering produced by it is so great, and the accepted methods of therapy are so unsatisfactory that any new method of treatment that offers relief is to be welcomed with open arms. On the other hand, the possibility of introducing dangerous complications by the use of any new method demands considerable caution and a careful study of contra-indicating factors.

Under the heading of arthritis we classify a heterogeneous group of clinical syndromes. It is quite likely that this heading covers a variety of diseases which differ not alone in their pathology but also in their etiology, and have a common denominator only in their visible point of attack,—namely, joint surfaces. One would hardly give credence to any proposed single cure for all classes of dermatitis, though the point of involvement is the same in all of these conditions. In the same way, one can hardly accept any one method of cure for the numerous ailments which happen to have as their common interest only a predilection for synovial membranes. It is, of course, conceivable that arthritis of a very limited type may result from changes in the adjoining bones, such changes being produced by abnormal parathyroid action. But it would be illogical to accept as a corollary the statement that arthritis can be cured by parathyroidectomy.

The use of parathyroidectomy as a therapeutic procedure in arthritis predicates disturbance of the lime-salt metabolism and is based on the fact that the parathyroid secretion mobilizes these salts. While the evidence is quite convincing that calcium-phosphorus deposits in the bone are affected by these endocrine glands, one can hardly accept, without some doubt, the statement that arthritis is a disease of mineral-salt metabolism. Calcium determinations have been made in arthritis by many observers, but the reports have varied. Some investigators report a marked increase in the blood calcium, others a marked deficiency. The writer has studied the serum calcium in thirty-seven cases but has found no change from the normal. In the same thirty-seven patients the blood phosphorus was studied with the idea of differentiating the hypertrophic from the infectious arthritic, but no uniform variation from normal readings was obtained. The only deduction that could be made was that the phosphorus level is lower in the osteo-arthritic than in the infectious arthritic. In fact, it is quite likely that phosphorus rather than calcium is the determining factor in these studies on calcification, a fact which is confirmed by subsequent studies. On the other hand, studies on individual specimens

of blood are likely to be incomplete because we have reason to believe that the blood is merely a vehicle transporting the calcium and phosphorus ions to and from the skeletal system without giving any accurate data as to the bone supply in this system. Certainly, from the data that we have on the mineral metabolism in arthritis to-day, we have no right to assume that arthritis is the result of calcium-phosphorus dyscrasia.

The action of parathyroid secretion is receiving considerable study, but our knowledge of this is still in such an undeveloped state that interference with the function of these glands can easily prove to be a double-edged sword. Most of the parathyroid therapy for bone conditions is based on the assumption that the hormone removes lime salts from the osseous tissue,—that is, that osteoporosis results from excessive parathyroid secretion in the body. Recent investigations indicate that this action is definitely a matter of dosage. It has been shown that injections of parathormone in rats can, in given doses, produce osteoporosis; while in others osteosclerosis results. Furthermore, the effect of parathormone in animals varies decidedly with the calcium-phosphorus intake. In other words, the diet is linked with the whole problem. If we are to expect some given effect on bone deposits from the use of this hormone, we shall first have to have a much more accurately correlated fund of information on dietary studies and effect of dosage of parathormone.

One other thought presents itself, and that is the question of what becomes of the lime salts that are moved from the skeletal system. Laboratory experiments have shown that the liberated calcium phosphate may be deposited in other areas,—such as the blood vessels and the kidneys, where as vicarious calcification very severe complications are produced. The importance of accurate knowledge on the production of such calcifications need hardly be stressed, since obviously the cure may prove to be much more serious than the disease. Surely it would appear desirable at the present time to entrust the proposed parathyroidectomy for arthritis to capable investigators rather than to accept it as a determined curative method for arthritis.

## CORRECTION OF COMPRESSED AND IMPACTED FRACTURES OF THE VERTEBRAE \*

BY JOHN DUNLOP, M.D., AND  
CARL H. PARKER, M.D., PASADENA, CALIFORNIA

Compressed impacted fractures of the vertebral bodies are no longer a rarity in the practice of the orthopaedic surgeon. This is due to two causes,—first, to the fact that with better x-ray equipment and technique the diagnosis is made more readily; and, second, to the universal use of the automobile, in our community the greatest single factor in the production of this injury. The automobile accident usually happens in the following manner,—The machine is driven at high speed through a dip or “thank-you-ma’am”; the individual on the back seat is thrown up to the top and then falls in the flexed position, thus producing the injury.

The characteristic symptoms of compression fractures which call for a thorough roentgenographic examination are:

1. History of adequate trauma;
2. Sudden severe localized pain at the time of injury;
3. Continued discomfort for hours and days following the accident;
4. Girdle pain.

The frequency of the injury is shown by the fact that since October 1927, we have treated fifty-eight compressed or impacted fractures, and in addition there have been a very considerable number treated by other surgeons in this community. It must also be distinctly understood that the type of case we are discussing excludes those with any cord injury. The future will decide whether similar treatment can be applied to such a group.

The experience of surgeons in various parts of the United States has demonstrated that compressed and impacted fractures can be corrected. To Davis of Erie, belongs the credit of being the pioneer in this field, and certainly his results have proved the possibility of success. The Boston school headed by Rogers has obtained equally striking results in a more conservative way. Both of these methods have accomplished excellent reductions.

Our method, though more bold than either of these, has the merit that the reduction is accomplished with ease, rapidity, and certainty. The result may be immediately checked by examination by a portable x-ray apparatus. We are of the opinion that the large number of reductions that have now been made, and the length of time which has elapsed, warrant general adoption of the procedure in most cases, if uncomplicated by cord injury.

\* Presented at the Annual Meeting of the American Orthopaedic Association, Toronto, June 18, 1932.



FIG. 1

Case 1. Mrs. O. This case illustrates the most common type of simple compression fracture through the upper third of the body.

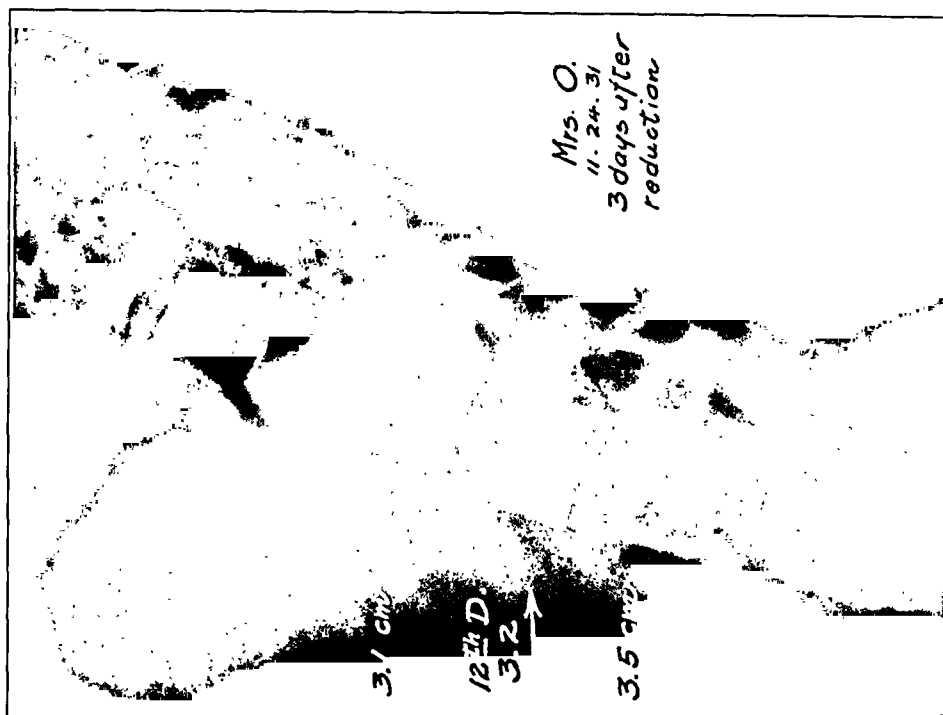


FIG. 2

Case 1. Mrs. O. An example of the nearly perfect reduction which can be attained in the ordinary cases.

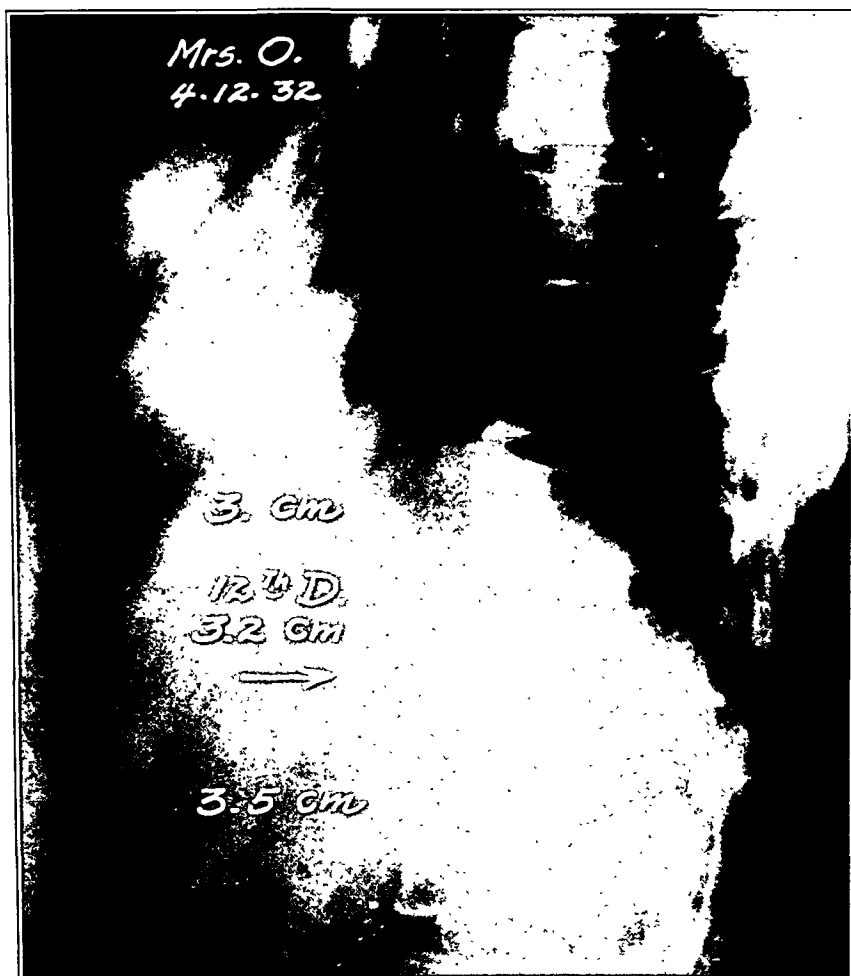


FIG. 3

Case 1. Mrs. O. Five months after reduction. The normal bone texture indicates that the strength of the bone has been restored.

The group which we have treated includes the cases seen within a week of the injury, and does not include old unrecognized cases in patients who have come in for painful backs.

#### JUSTIFICATION

With the introduction of such a radical change in the treatment, a number of questions have arisen as to the advisability of the procedure.

1. Are the results following such a procedure any better than with the old method of non-interference?

2. Does such a fracture heal after reduction by building new bone of sufficient strength to sustain the superincumbent body weight?

3. Can reductions be accomplished with sufficient certainty and safety to warrant the adoption of this method as a routine procedure?



4. In what way is treatment by reduction superior to an operation which results in fusion of the injured segments?

In answer:

*Question 1.* Are the results following such a procedure any better than with the old method of non-interference?

Yes, for these reasons:

A. Reduction of the fracture restores the normal alignment of the vertebral bodies, eliminates kyphosis and lateral deviations, and thus improves the general posture.

B. By restoring the normal relations of the articular facets, free movement of the spine is assured, and irritation is eliminated.

C. The hyperextension diminishes nerve-root pain.

D. The development of bone spurs and the bridging of the intervertebral spaces is less likely to occur, thereby assuring a more flexible spine.

*Question 2.* Does such a fracture heal after reduction by building new bone of sufficient strength to sustain the superincumbent body weight?

In the roentgenograms you will see that the bone has been rebuilt with remarkable solidity, and that in many instances the normal architecture has been so completely restored that the site of fracture cannot be recognized.

*Question 3.* Can reductions be accomplished with sufficient certainty and safety to warrant the adoption of this method as a routine procedure?

Yes. The roentgenograms shown here give a true picture of what can be accomplished. There has never been a single instance of injury to the spinal cord as a result of the reduction. The disagreeable symptoms which have followed the procedure have been limited to localized pain, nausea, and vomiting lasting two to three days, which may fairly be attributed to the marked hyperextension in the cast and to the anaesthesia. Two cases have had temporary ulnar palsies, which I believe to be due to the poorly applied traction with the sheet in the axilla.

In the entire group of patients two have died, one a year afterward from a cause not in any way related to the fracture; the other had a severe cystitis on admission and died of pneumonia seven weeks after the reduction.

*Question 4.* In what way is treatment by reduction superior to an operation which results in fusion of the injured segments?

Reduction results in a flexible spine, in place of a stiff spine with deformed segments.

Eikenbary's statistics indicate that fusion operations do not give results superior to those obtained by simple fixation.

#### PSYCHOLOGICAL EFFECT

An essential procedure in treating these patients is to procure their active cooperation and their confidence by showing them the roentgenograms made before and after reduction, and those taken after the removal of the cast, which show the solid healing of the injured bone.

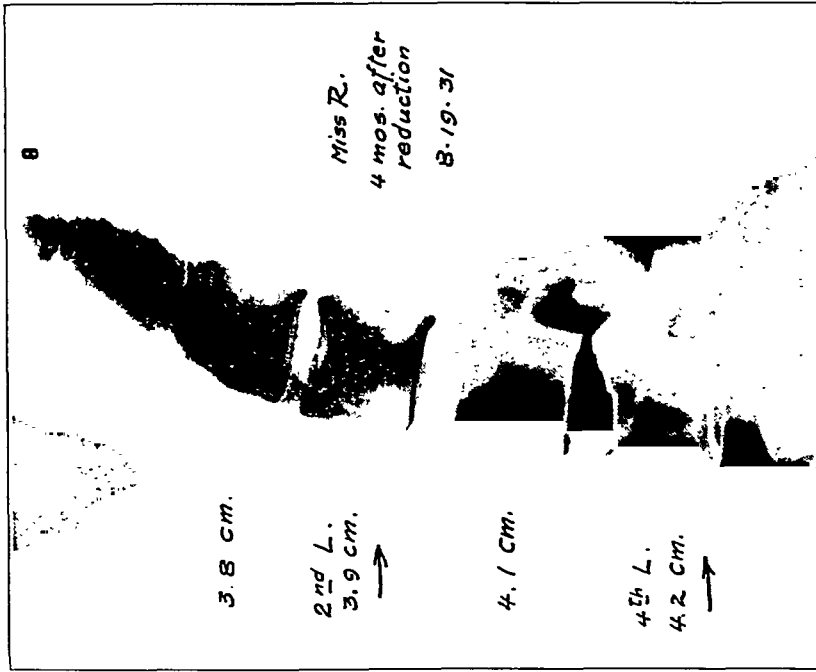


FIG. 5

Case 2. Miss R. Four months after reduction. The front of each vertebral body is now of normal height, the upper cortical plate of each bone still shows some deformity due to incomplete reduction.

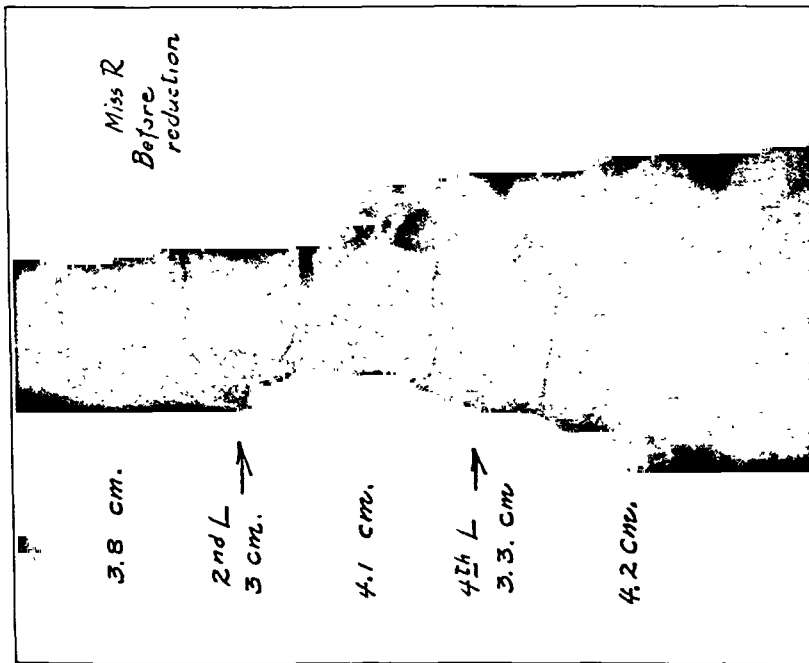


FIG. 4

Case 2. Miss R. Before reduction. Two vertebrae are fractured. Instances of injury to more than one bone are frequent.

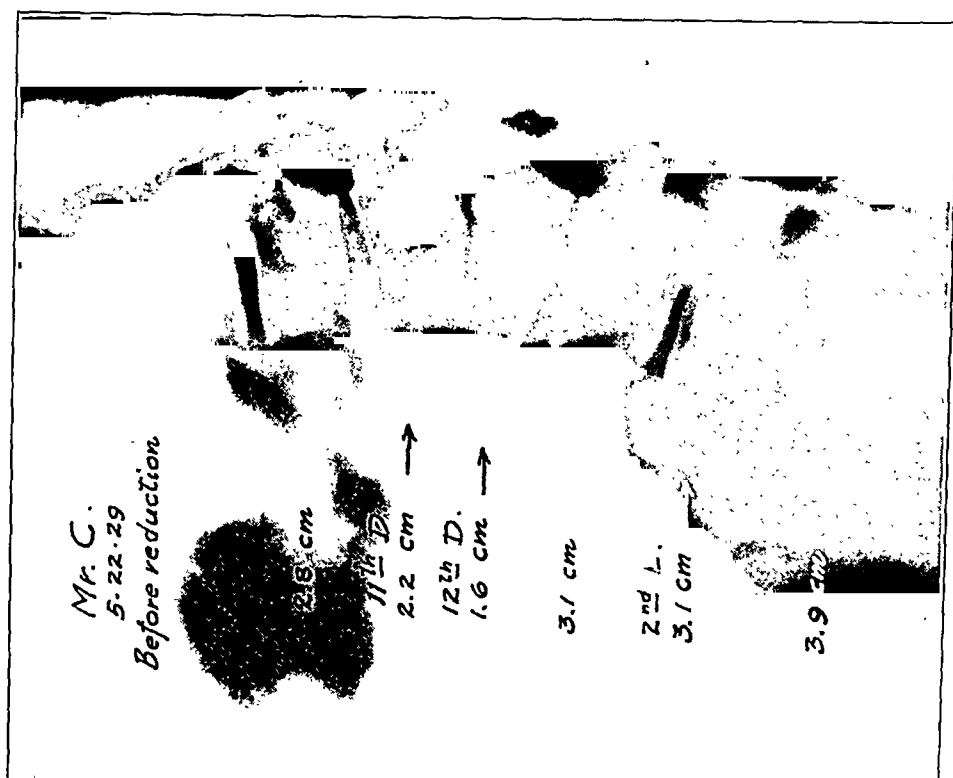


FIG. 6

Case 3. Mr. C. Multiple compression fractures of varying severity. Three vertebrae were injured.

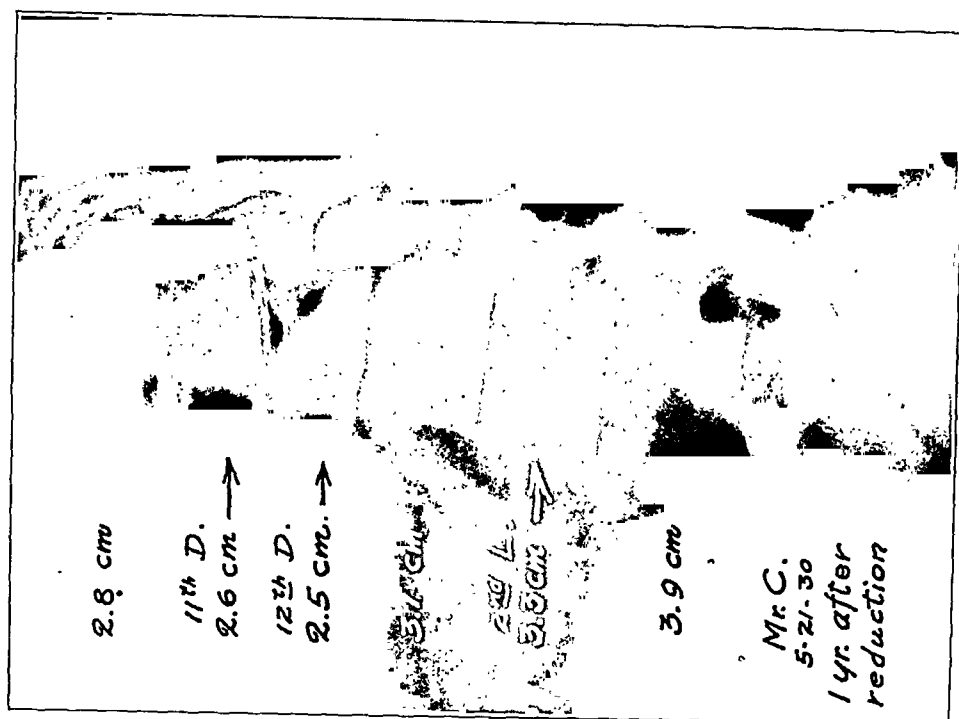


FIG. 7

Case 3. Mr. C. One year after reduction. An excellent reduction of the eleventh dorsal vertebra was obtained. The twelfth dorsal shows a fair reduction and good repair of the bone. The front of the body of the second lumbar vertebra was correctly reduced, while a

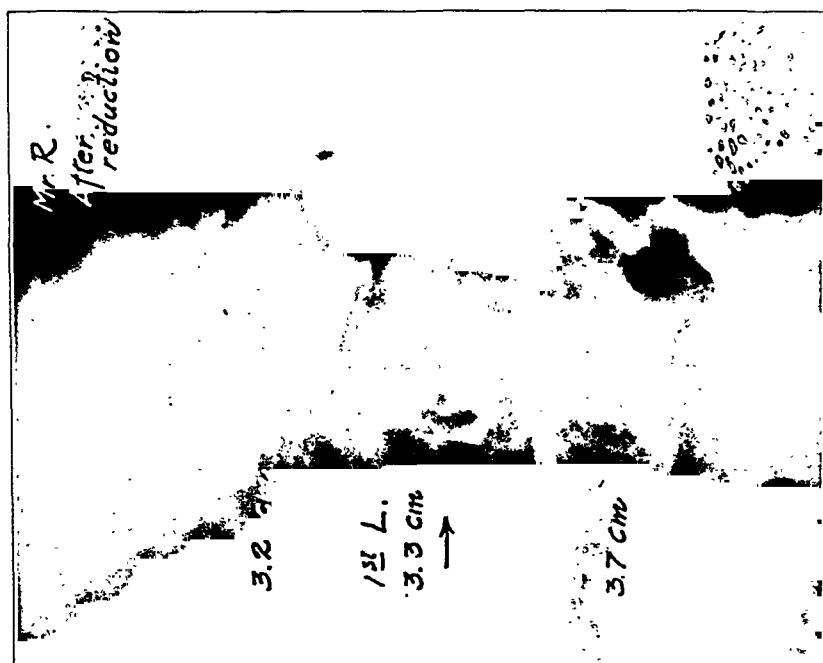


FIG. 9

Case 4. Mr. R. After reduction. A remarkable restoration of the form, size, and alignment of this vertebral body was obtained by controlled forcible hyperextension. The firm attachments of the bone to the anterior longitudinal ligament and to the discs must play an important part in bringing the fragments into position.

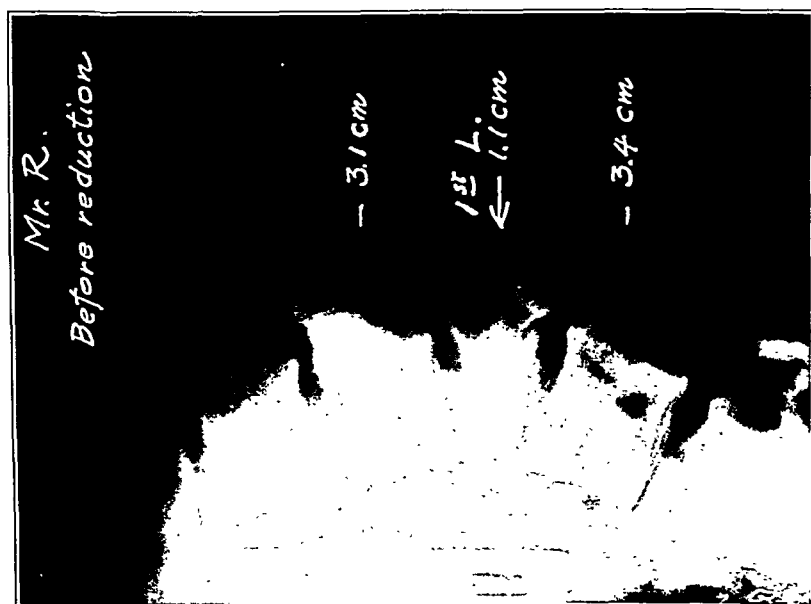


FIG. 8

Case 4. Mr. R. Before reduction. Compression, comminution, and kyphosis were all present.

In the Industrial cases the demonstration of the serial films before the Accident Commission should result in a fair award, instead of the high permanent disability ratings which have been the rule during recent years. The serial films are of equal importance in the medicolegal cases.

#### METHOD OF REDUCTION

The essential steps in the procedure can be enumerated as follows:  
Anaesthesia sufficient to obtain complete relaxation.

Breaking up the impaction or overcoming the compression by forcible hyperextension during traction.

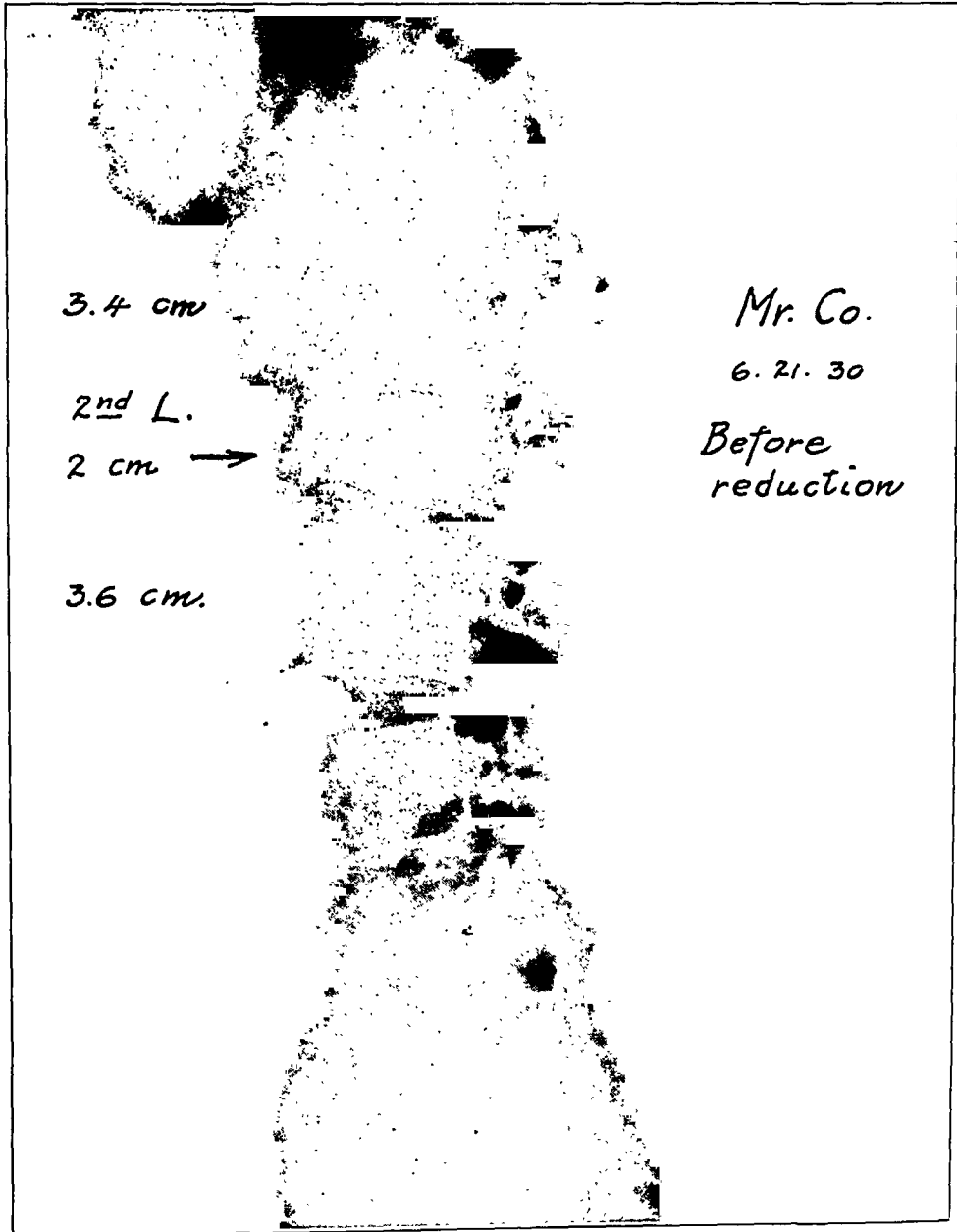


FIG. 10

Case 5. Mr. Co. Before reduction. The body of the second lumbar vertebra was badly comminuted and compressed.

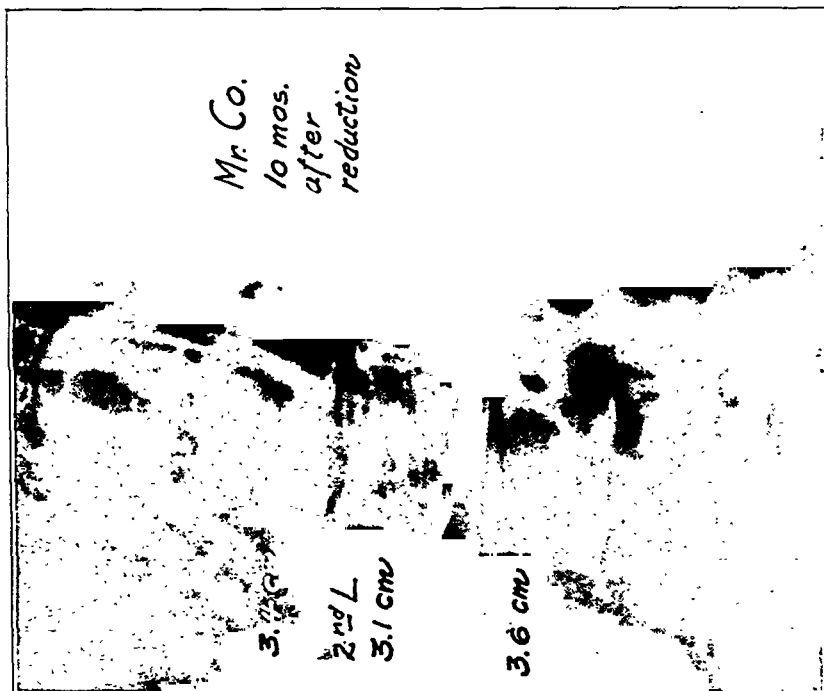


Fig. 12

Case 5. Mr. Co. Ten months after reduction. This case demonstrates the amount of bone repair which can take place. Note the strength of the new bone. Narrowing of the intervertebral space above was attributed to injury to the intervertebral cartilage.

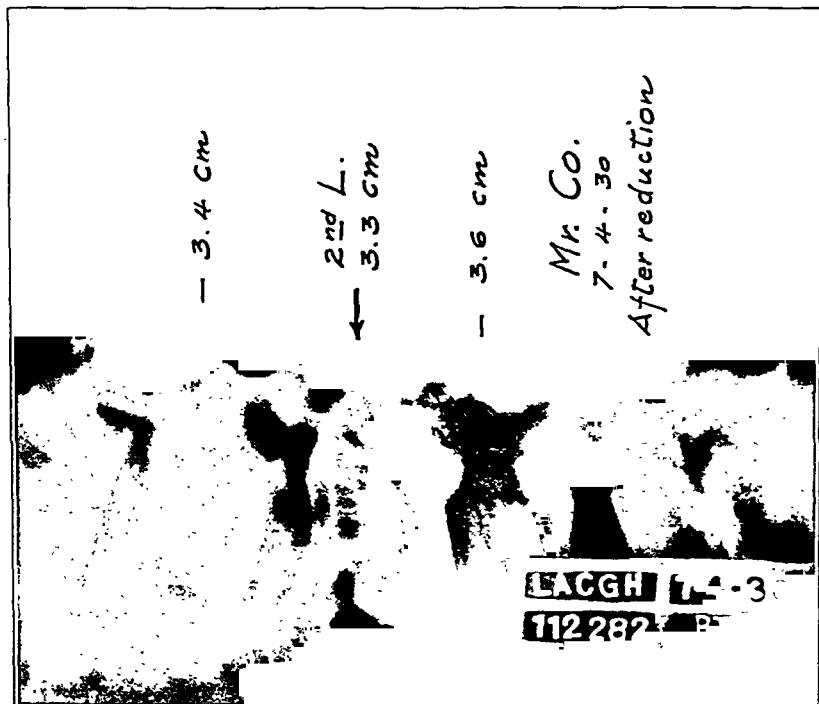


Fig. 11

Case 5. Mr. Co. After reduction. In spite of the comminution, the height, form, and alignment of the body were remarkably well restored by the reduction.

Reduction by placing the patient in marked hyperextension on a Goldthwait frame.

Application of a plaster jacket for permanent fixation in the corrected position.

Since it is of moment to follow the procedure with exactness, the minute details of the simplest and surest method will be described.

1. The preparation of the Goldthwait frame is of great importance. The bars chosen must be of such strength that they will sustain the patient's weight without undue yielding; on the other hand, the steel must be sufficiently compressible so that it will mold to the curve of the individual back. These bars are then bent to produce the maximum hyperextension in the individual, taking into consideration the location of the injury, the flexibility of the spine, the age and weight of the patient. The patient is then covered with stockinette and heavy felt is prepared for proper padding of the back.

2. The patient is put to sleep with gas, and is then given ether continuously in sufficient amounts to secure complete relaxation during the reduction and until the cast has been applied.

3. The patient is placed on the Goldthwait bars.

4. Extension and counterextension are applied by three or four assistants. The extension is obtained by direct pull on the legs and the counterextension by pull on sheets folded across the chest and under the opposite arm.

5. The operator stands on a platform of such height that his shoulder may be brought directly over the patient. A folded sheet is passed beneath the injured segments and is tied over the operator's shoulder. Then, while the assistants are applying the longitudinal extension and counter-extension, the operator applies controlled forcible hyperextension by lifting upward with his own back and shoulder. This movement results in the breaking up of the impaction. Several methods of breaking up the impaction have been tried. (One was described by the authors in the issue of *Radiology*

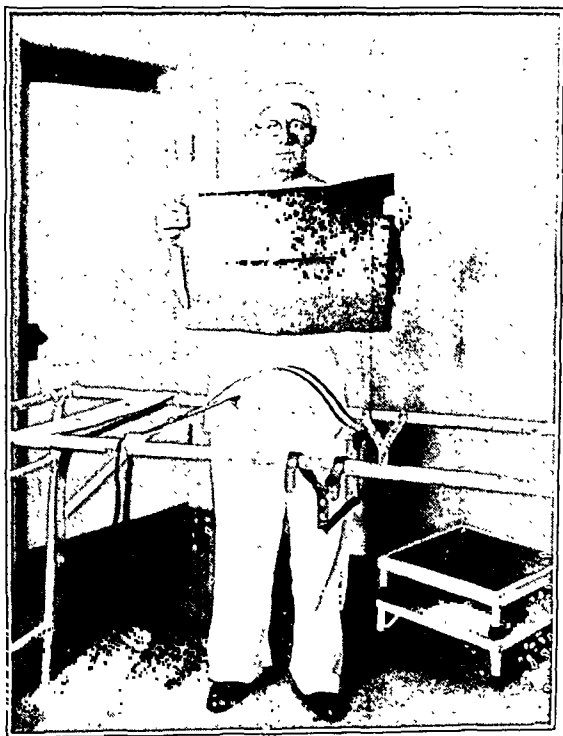


FIG. 13

The Goldthwait bars are here clearly shown with the curve used to maintain strong hyperextension. The heavy felt is used to pad the entire back during the four months in the cast. Time is essential for complete bone repair.

for August 1931, XVII, 228. Another method which has been used with success substitutes block and tackle suspended from the ceiling for the operator's shoulder.)

6. The patient is then adjusted on the frame and the result is immediately checked by a lateral view of the injured vertebra made with a portable x-ray machine.

7. As soon as a satisfactory reduction has been demonstrated, a plaster jacket is applied, extending from the clavicle to the pubis. A circular window, six inches in diameter, is cut in the cast over the epigastrium. A pillow is placed beneath the curve of the back while the cast is drying, in order to preserve the hyperextension.

8. In the after-care we have found it to be a great comfort to the patient to elevate the head of the bed about four inches. During the last four weeks in bed, massage and exercises for the legs should be given.

9. The patient is kept in the cast a minimum of fifteen weeks. Time is essential to the healing of the spongy and porous bone which makes up most of the structure of the vertebral body. Remember that this bone must be of sufficient strength to support the weight of that part of the patient's body above the injury.

During the time in the cast the patient is kept in the supine position, and is never turned completely on his side, and is never turned prone. For purposes of nursing care he may be turned eighty degrees from the supine position.

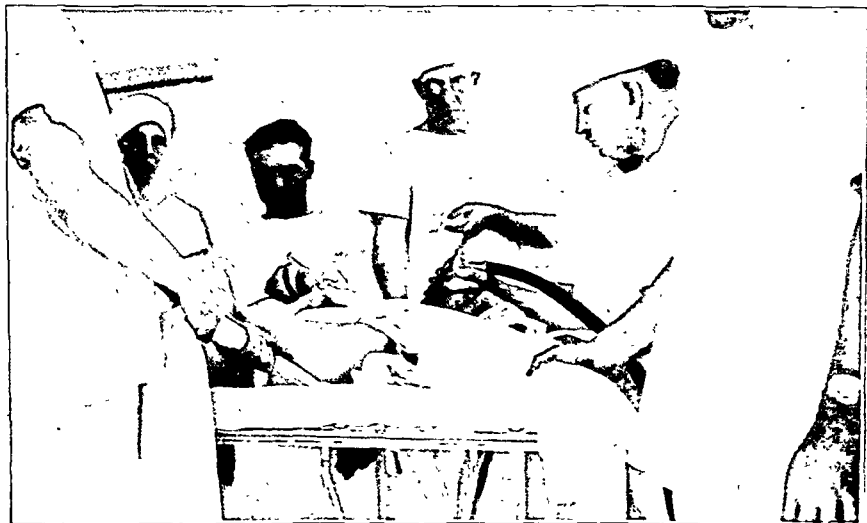


FIG. 14

This photograph illustrates the original method of reduction. A folded sheet has been passed beneath the injured segment. The ends are held by the operator and his assistant. Other sheets are crossed over the chest to permit strong counter-traction upward. The traction on the ankles is not shown. The arms are held out of the way by tying the wrists together.



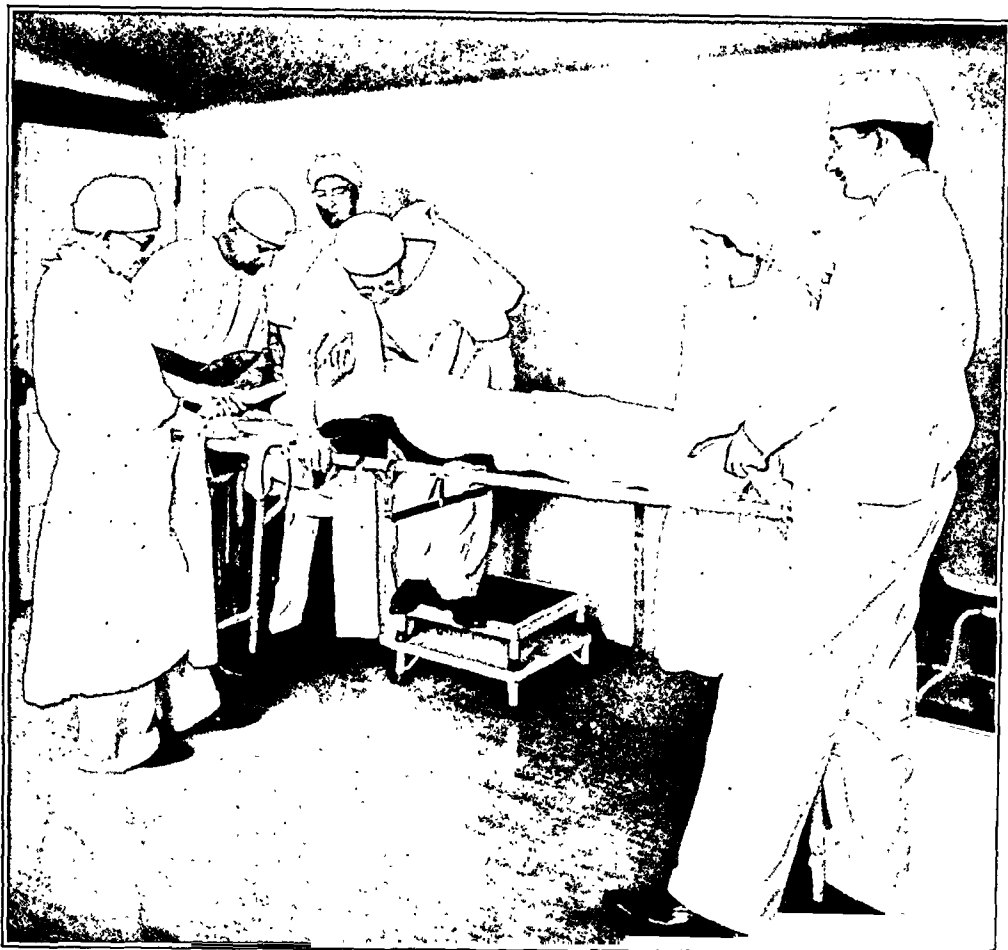


FIG. 15

This less radical method of applying the reducing force has been used where the injury has caused comminution of the body without deep impaction.

10. When the cast is removed, x-ray studies should show complete reproduction of the bone.

11. At sixteen weeks, the patient should be fitted with a Taylor back brace which is to be worn up to a year from the time of the injury.

It has been a surprise to see how perfectly the simple compression fractures may be brought into position; even where the bodies of the vertebrae are comminuted, the various fragments return to a nearly normal relation under this treatment, doubtless as a result of the firm ligaments that surround the bones and the close attachment of the compact upper and lower vertebral plates to the intervertebral discs. When the structure of the bone is taken into consideration, it is remarkable that the repair is so satisfactory. Filling in of fairly large spaces has been obtained and when once the new bone has been built, it appears to have ample strength to sustain the weight placed upon it. One patient, a stockily built motor-cycle officer, was able to return to active duty on his machine seven months after his injury. Subsequently he sustained two heavy falls from his motor cycle without any sign of injury to the repaired vertebra.



FIG. 16

A third method of reduction by the use of a sling and a block and tackle is the choice of some operators. Hyperextension is easily maintained while the patient is lowered on to the Goldthwait bars.

The more severe the bone injury, the less perfect is the reduction. This has been especially true where there has been much depression of the lateral portions of the vertebral bodies and where there have been central depressions. The fractures of the dorsal vertebrae above the ninth have not yielded as good results as when the injuries have been below this point. This we have attributed to the rigidity of the thoracic cage.

Damage to the intervertebral discs has been rather frequent, as evidenced by partial loss of the intervertebral spaces adjacent to the broken bones in the final roentgenograms. Several of the films have shown the appearance of localized protrusions of the nucleus pulposus.

At the suggestion of Dr. Kellogg Speed, a statistical study of final results in this group of cases is to be deferred until a large number of patients have been followed for a period of at least five years. The value of treatment by reduction must also be tested by the experience of many operators in different parts of the country.

The number of cases with cord injuries, which have been reduced, is still too small to warrant a report at the present time.

## AN OPERATION TO MAKE A POSTERIOR BONE BLOCK AT THE ANKLE TO LIMIT FOOT-DROP\*

BY A. BRUCE GILL, M.D., PHILADELPHIA, PENNSYLVANIA

To Dr. Willis C. Campbell belongs the credit of originating an operation to limit plantar flexion of the foot by means of a posterior ankle bone block. His operation was the first effective solution of the problem in certain groups of cases.

The author has used the following method of operation for the past five years as it has appeared a little more simple in technique than the Campbell operation, but not more effective.

But comparatively few individuals who have deformity of the foot from infantile paralysis require a bone-block operation to correct foot-drop. Talipes equinus, when present, is usually combined with a lateral deformity of the foot and frequently can be corrected when a stabilizing operation is performed for the correction of the latter. A lengthening of the tendo achillis; the transplantation of a lateral muscle forward to the dorsum of the foot; even the comparative lengthening of the tendo achillis that occurs when the subastragalar joint is excised in doing a subastragalar arthrodesis; the moving of a flail foot backward, as in a Davis horizontal transverse section, so that the heel tends to balance the anterior part of the foot, together with the production of scar tissue that results from freeing the lateral ligaments of the ankle from their malleolar attachments—all of these procedures tend to correct an ankle foot-drop.

The author has found the bone-block operation useful in two types of cases. One type is the flail or dangle foot. There is a complete paralysis of all muscles. When the patient lifts his foot from the ground the weight of the anterior part of the foot causes it to drop. Unless the patient raises his knee higher than normal in walking and gives his foot a peculiar fling his toes scrape the ground or catch on some irregularity and trip him. If you stand behind him as he walks away from you in his bare feet, you see at every step the plantar surface of the foot. A stabilizing operation for lateral deformity of the foot may or may not be necessary, or one may have already been done.

If such operation is indicated the author employs the procedure published in a former paper.<sup>1</sup>

"A subastragalar arthrodesis will correct any tendency to a lateral deformity but will not correct the dropping of the foot in front. A horizontal transverse section with moderate backward displacement of the foot will correct the foot-drop as well as the lateral deformity. The foot need not be placed backward so far as in cases of decided calcaneus, nor is any anterior bone-block required. Two factors probably are active in preventing the dropping of the foot: first, the relative increase in weight of that part of

\* Presented at the Annual Meeting of the American Orthopaedic Association, Toronto, June 17, 1932.

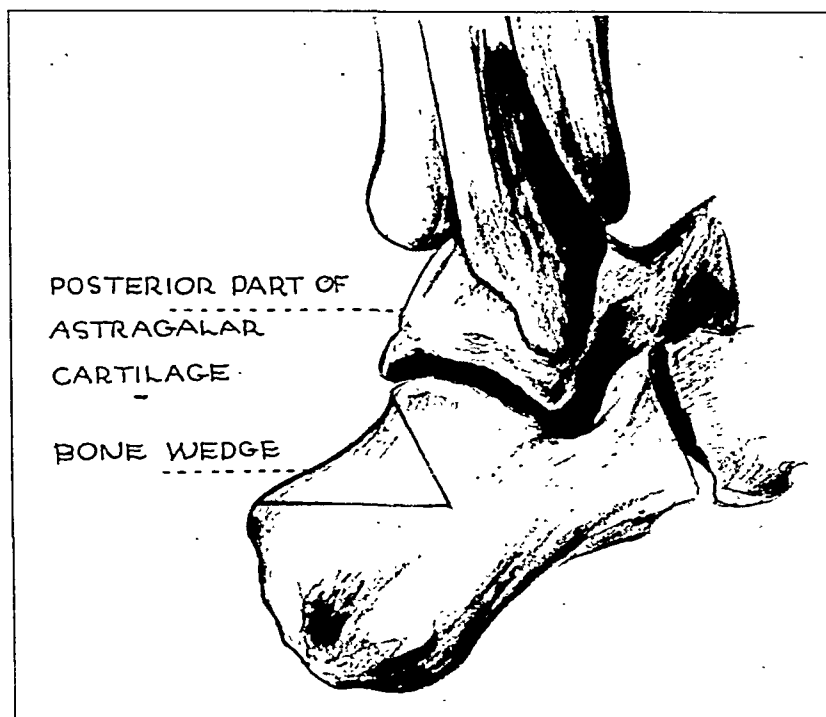


FIG. 1  
Showing the foot in dorsiflexion.

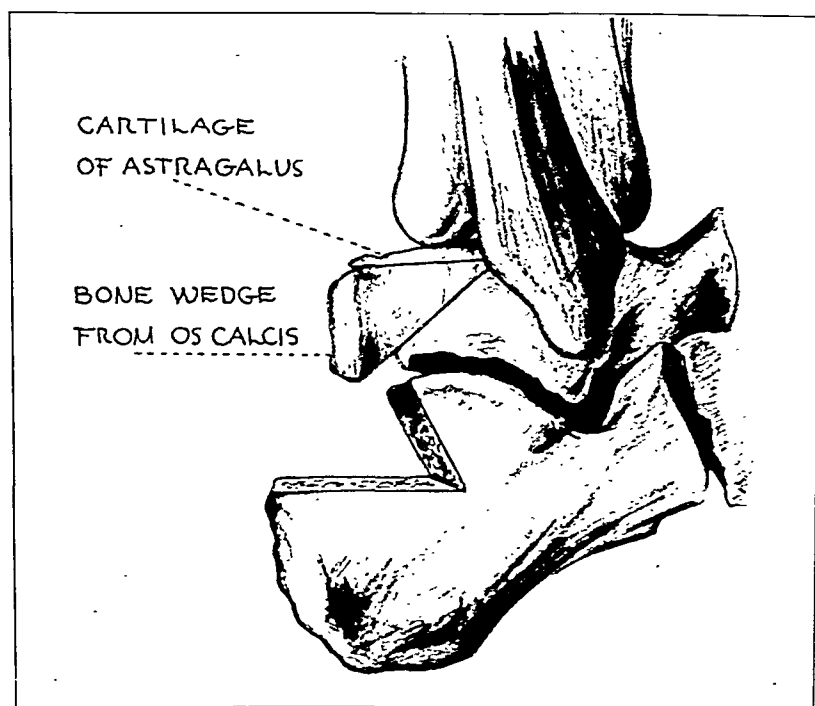


FIG. 2

the foot which is behind the ankle joint which tends thus to balance the weight of the anterior part, and, second, the scar tissue which forms about the ankle joint after the lateral ligaments have been elevated subperiosteally from the malleoli."

If foot-drop has not been corrected in some such manner at the time of a fusion operation, a posterior bone block is indicated; or the two operations may be combined at the same time, if the surgeon so desires.

The second type of case is that in which a strong tendo achillis is not balanced by anterior muscles. In this type a posterior ankle block is the only sure method of correction that the author knows, aside from an arthrodesis of the ankle, which, of course, is out of the question. It may be noted in passing that if there is a paralysis of the quadriceps femoris muscle, a moderate foot-drop with a tight tendo achillis is desirable in stabilizing the knee.

#### DESCRIPTION OF THE OPERATION

A skin incision is made parallel to the tendo achillis. The latter is exposed and divided Z-fashion. An incision is then made longitudinally through the underlying fat which is then scraped to both sides to expose the posterior aspect of the ankle joint and the top of the os calcis. The ankle joint is opened.

The foot is dorsiflexed to the limit of motion. This brings the posterior portion of the articular surface of the

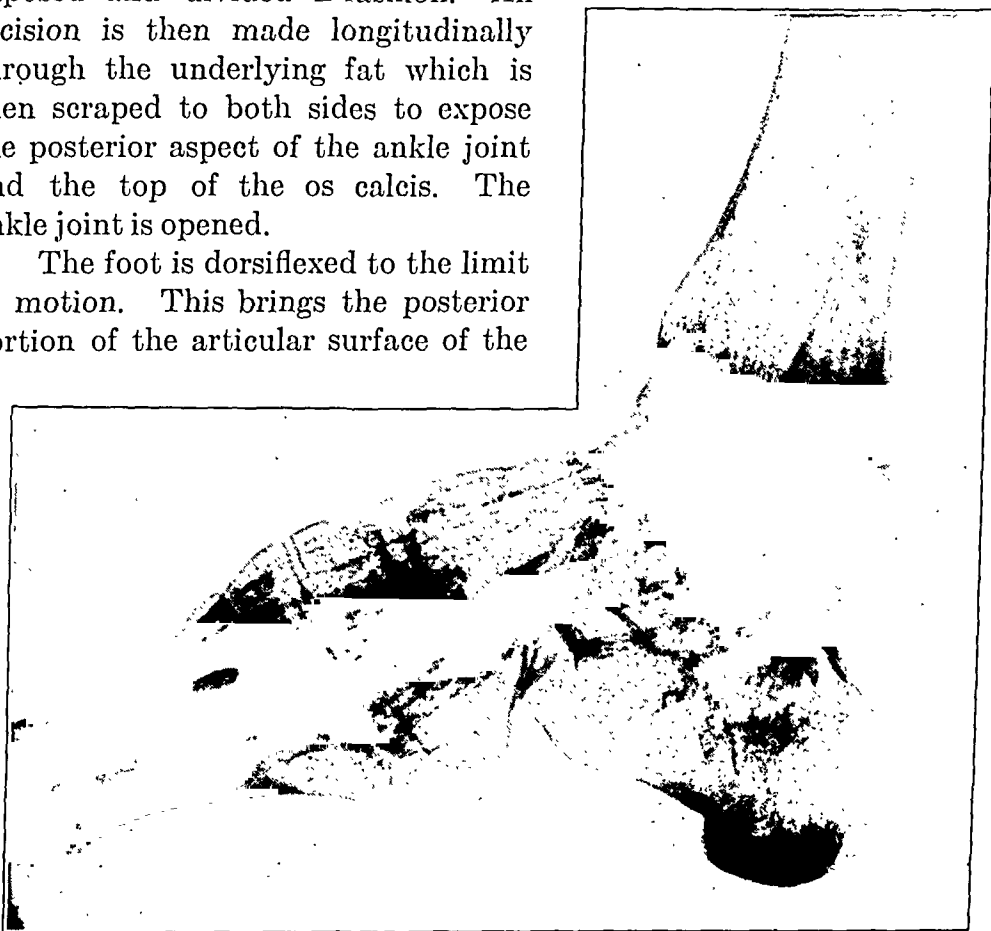


FIG. 3

Showing final result of bone block two years after operation. Note that the space in the os calcis from which the bone wedge was removed is now fairly well filled in with new bone.

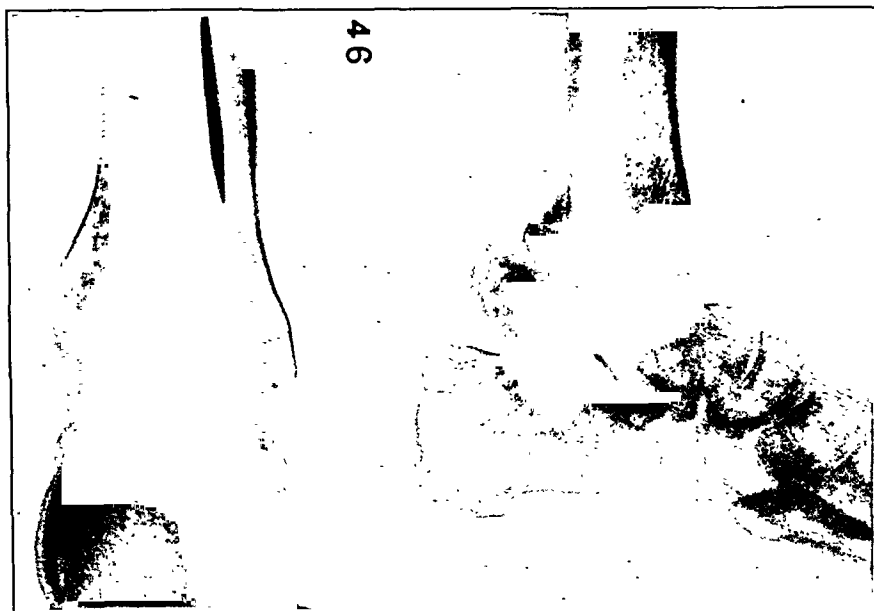


FIG. 4

Showing result one and a half years after posterior bone-block operation.

astragalus into view into the wound as shown in Figure 1. Sometimes the astragalus has a tail which extends beyond the cartilage, sometimes it does not.

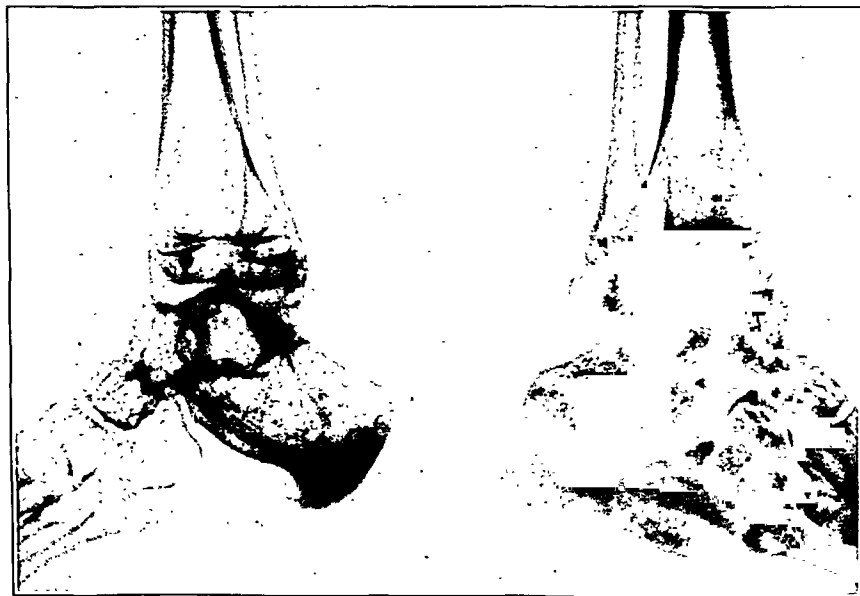


FIG. 5

Showing result of anterior ankle bone-block for calcaneus eighteen months after operation.

With a broad, thin osteotome the cartilage, with a thin portion of bone of the astragalus, is lifted upward from behind until it comes into contact with the posterior lip of the tibia. The angle of the wedge-like space thus formed lies well forward beneath the cartilage and in front of the posterior lip of the tibia. If the surgeon is careful, this plate of cartilage and bone bends upward at its anterior aspect without breaking off (See Figure 2).

A wedge-shaped piece of bone is then removed from the upper aspect of the os calcis and is driven firmly into the space beneath the superior portion of the astragalus. It will then be observed that the foot is maintained firmly in a position of dorsiflexion.

The tendo achillis is sutured with the necessary amount of lengthening. The skin wound is closed with No. 0 or No. 1 twenty-day chromic gut. The foot is dressed in plaster in slight dorsiflexion for three months.

The merits of this method of operation are its simplicity, the ease and speed with which it is done, the fact that no other incision or operation is required to obtain bone for the wedge, and the fact that it has withstood the test of time.

1. GILL, A. BRUCE: Fusion Operation on the Foot. J. Am. Med. Assn., LXXXIX, 1829, 1927.

## CONGENITAL METATARSUS VARUS \*

BY CHARLES W. PEABODY, M.D., AND FELIPE MURO, M.D., DETROIT, MICHIGAN

This paper represents a study of a certain typical congenital deformity of the foot, which in the English current literature of the last twenty-five years has received only one—and that a comparatively brief—reference, and which the current English orthopaedic texts either fail to describe entirely, or give only passing mention. Yet this study is based on some fourteen cases nearly all encountered in one clinic in the past five years. Since 1904 the Continental current literature has provided a respectable bibliography, although leaving an impression quite inconsistent with the frequency with which this deformity has been met in the period covered by this study. Because of their relatively close similarity, the series includes some cases in which the term congenital metatarsus adductus may be more exact, and some in which the available data has not permitted differentiation. The previous literature also has tended to group the two types without always recognizing them as separate entities. The general deformity being considered here, when occurring in a major grade, has certainly such well defined differential characteristics as to make it absolutely separable from congenital talipes equinovarus as a clinical entity. However, in a minor grade it might easily fail to demand attention from absence of any obvious effect on function, or from being mistaken for a mild residual of talipes equinovarus.

Classification of our deformity with common club-foot seems quite improper from a number of striking factors in the pathology. In the first place, equinus is never present in any degree. In the second, the sole of the foot is always flat, or nearly so. Thirdly, in spite of a first impression of a varus foot, there is seen to be no ankle varus or supination at the subastragaloid joint, but, on the contrary, valgus or pronation, with marked inward rotation and luxation of the head of the astragalus, the scaphoid and mesial cuneiform being displaced laterally. Although this posterior foot deformity might be an inevitable compensation from functional adaptation to a preexisting forefoot varus, or to manipulative correction thereof, the European literature contains a report (Nové-Josserand) of a postmortem dissection in a three months old untreated case, in which the tarsal valgus was a notable feature.

The major element of deformity, of course, involves the forefoot, beginning with the cuneiform bones, which are rotated in a varus direction and are abnormally overlapping, so that the upright perpendicular might pass through all three of these bones. More striking is the deformity of the metatarsals. To a slight degree the fifth and to a marked degree the fourth, third, and second metatarsals are incurved in their diaphyses

\*Presented at the Annual Meeting of the American Orthopaedic Association, Toronto, June 17, 1932.



and to some degree dorsally convex. The first metatarsal is usually straight, but articulates at its base with the mesial aspect of the inner cuneiform and makes a marked varus angle with the mesial aspect of the foot back of this point, the greatest concavity being between scaphoid and metatarsal, and the cuneiform tending toward a lateral position with respect to the scaphoid.

In our series the younger cases, however, have shown frequently no incurving of the metatarsals, but a distinct adduction deviation of the metatarsus on the tarsus, but with the same abducted or valgus position of the calcaneum and inward rotation and depression of the talus. It is this group that present the possibility of a separate classification of "metatarsus adductus". Yet the stresses resultant from walking on this type of foot would be very likely to bring about the incurving and luxations noted in the older cases. The typical cases of this latter pathology described in the literature were not observed in early childhood. On the other hand, one case in our series was a six-weeks-old infant with x-rays showing most indisputably some incurving of the shafts of the metatarsal bones, apparently duplicating on the infantile scale the typical deformity of the older cases. This represents the most definite evidence yet offered, apparently, in support of the proposition of metatarsus varus and metatarsus adductus, originating congenitally, as separable clinical entities.

Metatarsus adductus may be a proper description of a common residual stage in the course of treatment of congenital talipes equinovarus, in which the deformities of the posterior foot and ankle have responded to corrective treatment more rapidly and completely. In continuing these efforts, often some overcorrection of the ankle varus results before the adduction of the forefoot has been overcome, and the whole foot will thus contain the criteria of the essayist's lesion of congenital metatarsus adductus,—namely, valgus posterior and varus anterior deformities. Hence for this series we have excluded any cases which had any history of primary equinus deformity. To illustrate this point, x-rays will be shown of a nine-year-old child, in which the pathology is quite typical of congenital metatarsus varus or adductus, but in this case there was an adequate history of original talipes equinovarus and usual treatment.

It may be significant in our series, as well as in most of the previously reported ones, that deformity was not noted in infancy and usually not until walking began, and that the deformity became more apparent as time went on. Functionally, the effect in the smaller children was of tripping and stumbling. In the older children the outer border of the foot became callous and painful, the shoes became out of shape and were quickly worn through, with clumsiness persisting in the gait.

Etiologically, the theories commonly put forward have been those in the past frequently ascribed to talipes equinovarus,—namely amniotic compression; and no theory involving primary structural defect or alteration of anatomical arrangement, etiologically suggestive, has been put forward, with one exception. This was a short contribution by Bank-

hart, about ten years ago, who, after emphasizing both the clinical familiarity of many with this entity, and its absence of recognition in text and literature, reported three cases in children operated upon below the age of ossification of the internal cuneiform. He considered, from his operative inspection, that the latter bone was absent, and by this failure of development was responsible for the deformity. In the light of findings to be described in the following pages, it may be interesting to note that he also mentioned seeing some variation from normal in the insertion of the anterior tibial tendon. All the cases in our series, observed after the normal age of ossification of the internal cuneiform, have shown roentgenologically apparently normal development of this bone, and the same has proved to be the case in the reports in the literature illustrated by roentgenograms.

As will appear in our illustrations, operative findings in one case of this series may indicate another etiological theory. The patient was an eight-year-old-boy with bilateral, typical, congenital metatarsus varus. In planning operative correction, it was decided to free the luxated base of the first metatarsal. On exposure of this area, there was at once noted a distinct, anatomical variation in the insertion of the tendon of the tibialis anticus, which normally inserts in the mesial aspect of the cuneiform. In our case it was found to have no tarsal attachment, but continued distally in its sheath in a partially dorsal position until opposite the shaft of the first metatarsal, meeting this bone at a wide angle, and passing beneath it to the plantar surface, when it seemed to fan out in multiple fibers finding attachment to the plantar fascia or the mesial portion of the transverse metacarpal ligament. The mechanical effect of this arrangement in functional activity would seem adapted to bring about the exact deformity of the forefoot that prevails in metatarsus varus. Identical findings prevailed in both feet of this patient.

Interest in the subject which this operative case aroused led to a review of the other cases available in the files, but opportunity has not yet presented to check the observation as a constant clinical finding by exploration in additional cases; so it is hoped that others may be stimulated to make such investigation.\*

From the angle of methods and results of treatment, it may appear that the cases of typical metatarsus varus fall into a different group than those classified as metatarsus adductus. In the latter, manipulative treatment has seemed quite successful and reliable in obtaining correction of deformity, both by functional and cosmetic standards, as well as by those of anatomical skeletal restoration. But in the former the majority of the reports from the literature emphasize the difficulty in obtaining anatomical restoration by any method, and the two cases of major deformity reported here have likewise failed to show, in final x-rays, any very successful result from operative attack, although functionally and cosmetically the feet were greatly improved. Manipulative treatment

\*Dr. R. V. Funsten, in a late communication, reports similar findings at operation on a case of this deformity.

carries the drawback that corrective force is required in opposite directions on tarsus and metatarsus, with obvious obstacles to its practical application, so that correction of the forefoot deformity would tend to be at the expense of increasing the tarsal valgus of the posterior foot.

Individual metatarsal osteotomies have been commonly practised, and theoretically seem promising in results, but practically, in accomplishing realignment of the forefoot deformity, such tension and strain on the soft tissue attachments between the several metatarsal bones are involved, that, after simple osteotomies of the latter, there still remains great resistance to correction. Two cases in this series seemed to forcibly demonstrate this point.

Recommendations for operative treatment by various writers have included also: excision of cuboid, resection of the bases of all the metatarsals, osteotomies of shaft, transverse wedge-shaped osteotomy, and incision through Chopart's joint. The writers' observations and experience seem to suggest, in cases of major deformity, indication for attack by the following steps: (1) excision, probably *en bloc* and through a central incision of the bases of the three middle metatarsals; (2) subcutaneous osteotomy of the fifth; (3) mobilization and reduction of luxation of the first metatarsocuneiform joint with appropriate attention to insertion of the tibialis anticus; (4) consequent manipulation to produce a completely abducted and pronated foot. At a later sitting the reconstruction procedure of Hoke should be done in the joint of Chopart, and the posterior foot deformities thus corrected. It seems very doubtful if any program short of this will give an ideal result in a high-grade metatarsus varus, and this procedure probably must be postponed till later childhood. The value of manipulative treatment at an earlier age should be carefully weighed against the possibility of decreasing one deformity at the expense of the other.

Certainly, from this study, it would seem indicated, on encountering forefoot varus in children without history of typical congenital talipes equinovarus, to analyze the set-up of the rest of the foot as well, and to study it roentgenologically before classifying the case or proceeding to corrective measures.

#### REVIEW OF LITERATURE

In the orthopaedic text-books of Bradford and Lovett, Sever, Albee, Taylor, and Tubby, no mention of metatarsus varus occurs. Whitman, in his text, devotes a few lines, describing the condition only as an adduction of the metatarsals on the tarsus, not mentioning curving of the individual metatarsal bones, and states that it "may be congenital, a variety of talipes varus, but more typically is combined with a posterior valgus as an acquired condition". Jones and Lovett devote about four lines to the condition, in which the lesion is considered rare and described as "an adduction of the phalanges on the metatarsal heads", usually congenital, sometimes acquired.

In the current medical literature in English, the only reference discovered is that of Bankhart in 1921, previously mentioned.

The Continental current literature of the last twenty-five years includes a very considerable bibliography, with a few scattered previous references. The first detailed description and analysis apparently is that of Cramer in 1904, who closely studies and analyzes an adult case, and for the first time considers the possibility of a congenital etiology, previous conceptions having been of an acquired defect.

Helbing, in 1905, reported four cases out of 5000 children admitted to Hoffa's clinic and, in 1909, Froelich brought the literature up to date in report of a single case, in which, however, no mention was made of deformity save in metatarsus; but in 1910 Nové-Josserand published an interesting study of a necropsy dissection in a three-months-old child in which all the deformities were revealed. In 1914 Van Neck reported a good operative result under the title of metatarsus varus, but his x-rays showed only metatarsus adductus.

An excellent review of literature and detailed study of this deformity was contributed by Ettore, in 1921, twenty-nine cases in previous reports being cited, with addition of seven more out of 480 congenital foot deformities at the Clinica Ortopedica of Milan. His own series was the first limited to roentgenologically-shown curving of metatarsal bones, with simple adductus considered less common, and evident in only one case of his series. He was not satisfied with previous etiological theories, and felt that some muscle imbalance must be responsible.

Although since 1921 more than twenty articles have appeared in the European Continental literature, one very outstanding and detailed contribution, that of Madier and Massart in 1923, deserves special emphasis and should be referred to by anyone interested in the subject. These observers report six cases, seen in one year in one clinic, emphasize the double character of the deformity, prefer to subdivide the cases into adductus and varus groups, and stress the posterior variation as the primary difficulty, with the conviction that attack thereon rather than on the metatarsus is the key to correction. The technique used for varus type is deep mesial incision of the Phelps-Kirmisson type, going completely through all soft parts into the joint of Chopart and, in particular, dividing the calcaneoscaphoid ligament. In the adductus type, they recommend intervention on the metatarsals.

In summary, therefore, the literature as abstracted and in many additional single case reports seems to emphasize the not particularly infrequent occurrence of a congenital foot deformity of apparently varus character, yet separable from the common talipes equinovarus, most uniformly combining opposite distortions of hind foot and forefoot, the latter most commonly involving a varus curving of the individual metatarsal bones as well as a mesial distortion of the metatarsus as a whole, but occasionally presenting only an adduction of the metatarsus on the tarsus. Etiological explanations have been theoretical and generally

admitted as unsatisfactory, and have not included any specific developmental defect or variation as causative. With the exception of the adductus group, treatment by a variety of closed and open methods has given only fairly satisfactory results and without complete anatomical restoration. A possible exception appears in the report of Madier and Massart although not adequately supported by postoperative roentgenograms.

#### CASE STUDIES

The cases studied by the writers number fifteen, six single, the remainder bilateral. Fourteen have been classified as either primary congenital metatarsus varus or as metatarsus adductus. Of these, seven were male and seven female. The additional case is presented as illustrating, at the age of nine, a deformity of mild grade, but combining the fundamental characteristics of the primary deformity, including some curving of the individual metatarsals, with evidence indicating a typical talipes equinovarus at birth with the usual treatment thereof. Of the series typical x-ray evidence is available in ten, with the remainder receiving clinical observation only, and so not permitting positive subdivision into varus and adductus types. However, in this smaller observed group, the history was specific, the clinical description exact, complete, and supplied by an experienced observer, some possible cases not meeting these qualifications being thrown out. The whole group represents cases observed during a period of five years, and, with exception of one case, in a single, though rather large, orthopaedic clinic.



FIG. 1

Case 1. Wm. Y. Preoperative roentgenogram.



FIG. 2

Case 1. Wm. Y. Operative findings. Tendon of tibialis anticus exposed and retracted as it lies free in its sheath beside the shaft of the first metatarsal bone. Knife blade lies in intervening space. Tendon continues under ball of foot toward other metatarsal heads.

Of the group in which roentgenograms are available, eight are classified as varus cases, two as adductus; three of the former were treated by bone operations, the deformity being extremely high-grade in two; the case reports of these are included in detail. The remainder were treated

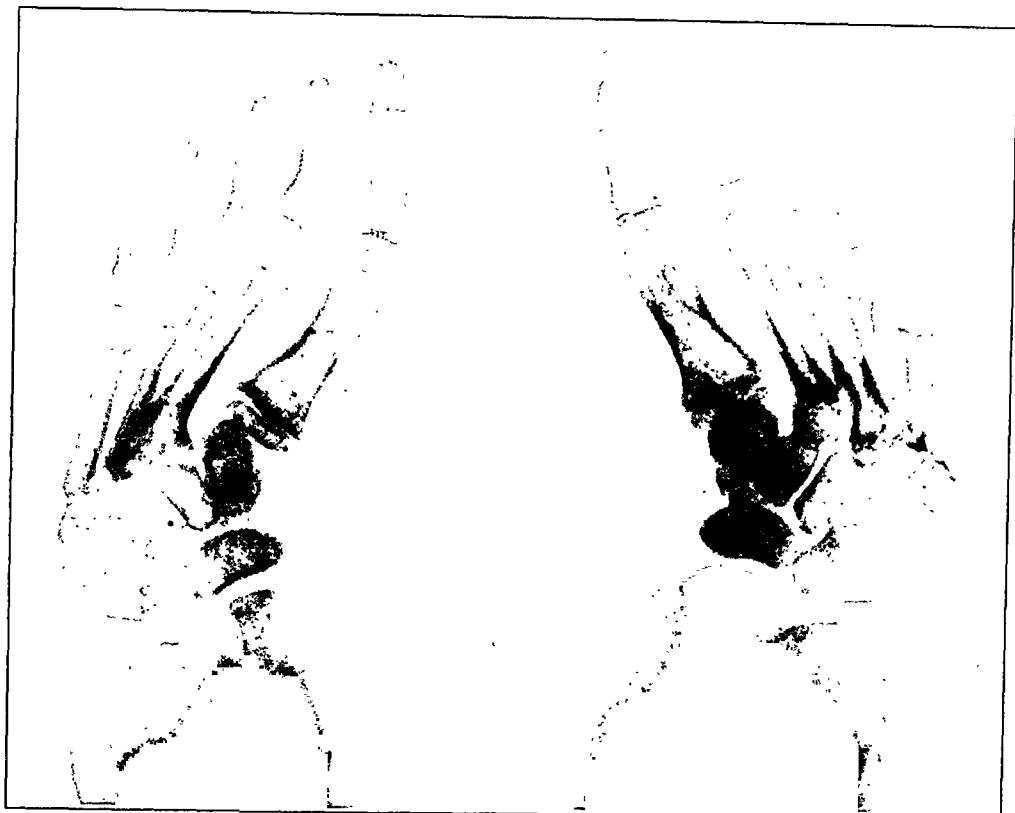


FIG. 3

Case 1. Wm. Y. Postoperative roentgenogram. Compare with Fig. 1. Some success in restoring relationships at base of first metatarsal. Forefoot is straighter, but posterior valgus and anterior varus still make long axis of foot sinuous in spite of extensive surgery.

by manipulation, but few of this group are found to have final x-rays. The ages of the cases treated ranged from two to eight years. Clinically the results of treatment of all were judged satisfactory, except in one

child of eight in which case there was a relapse. The high-grade cases were greatly improved functionally and cosmetically, but by x-ray standards left much to be desired. Case 1, referred to in the introduction, may throw some light on the question of etiological factors.

CASE 1. Wm. Y., aged eight, (Case No. 3498, Sigma Gamma Clinic) had history of bilateral deformities, first noticed at six months of age (Figs. 1, 2, 3, 4, and 5). With walking, deformity seemed to gradually increase, until the outer border of the forefoot only was used, and the shoes would not retain their shape.

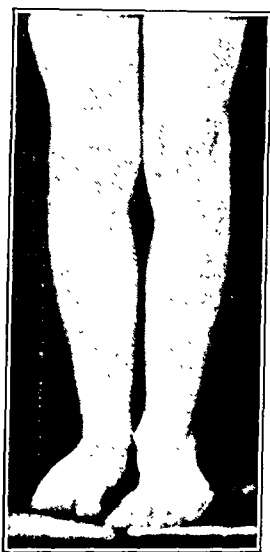


FIG. 4

Case 1. Wm. Y. Before operation.

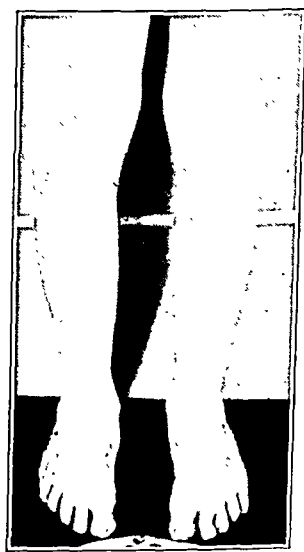


FIG. 5

Case 1. Wm. Y. After operation.

Interfering and stumbling was a marked factor in earlier years. Examination showed pronation of os calcis, mesial luxation of head of the talus, with convexity of the inner border of the foot in its hind portion, but with a sharp concavity in the mesial border at the joint of Lis Franc, the forefoot of the mesial border being in sharp varus to the end of the big toe. The outer border of the foot was markedly convex in its anterior two-thirds. (The angle

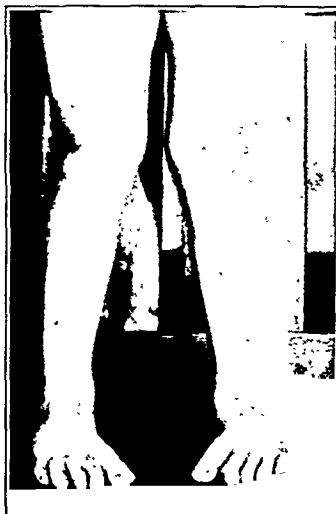


FIG. 6

Case 2. Alice D. Before operation.

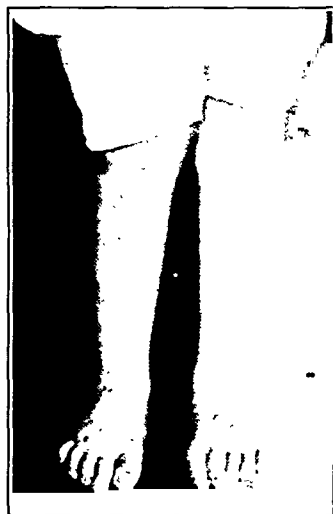


FIG. 7

Case 2. Alice D. After operation. Note contrast with postoperative x-ray findings.

of photography tended to underemphasize these findings.) In walking, the varus element seemed more marked; progression seemed to be off the outer border of the metatarsus,



FIG. 8

Case 2. Alice D. Postoperative roentgenogram. Original films lost, but a great deal of correction has been obtained. Note, however, residual disturbed relations at base of first metatarsal.





FIG. 9

Case 3. Robert R. Preoperative roentgenograms. See Fig. 10.



FIG. 10

Case 3. Robert R. Postoperative roentgenograms. Some correction obtained by exenteration of cuboid (Ogsten operation) and manipulation.

with the inner border raised from the floor save for the end of the big toe. A wide base was necessary to prevent interfering. While no knee valgus was present, gait seemed favorable for development of same. (Question of knee valgus of adult cases in early literature being secondary?) Roentgenograms obtained showed typical deformities as illustrated.

Open operation was performed by one of us (C. W. P.) on November 18, 1929, and the striking and suggestive tendon variation described in the preceding pages found in both feet. After transfer of tendon to cuneiform and capsulotomy of joint at base of first metatarsal, an oblique wedge-shaped resection was made through a separate incision of the bases of the other metatarsals, and the forefoot then manipulated, but with less overcorrection obtained than was hoped for. Complete reversal of deformity apparently necessitated reversal of the echelon-formation relations of the individual metatarsals and toes, which obviously would be resisted by the interosseus structures. After several casts a very symmetrical foot resulted on one side, but was not obtained on the other until a further wedge resection was done. The feet have been observed at intervals to date; they show normal function, normal shoe wear, and externally a nearly normal appearance; but late roentgenograms indicate imperfect skeletal relations, especially of the astragalus or posterior tarsus.

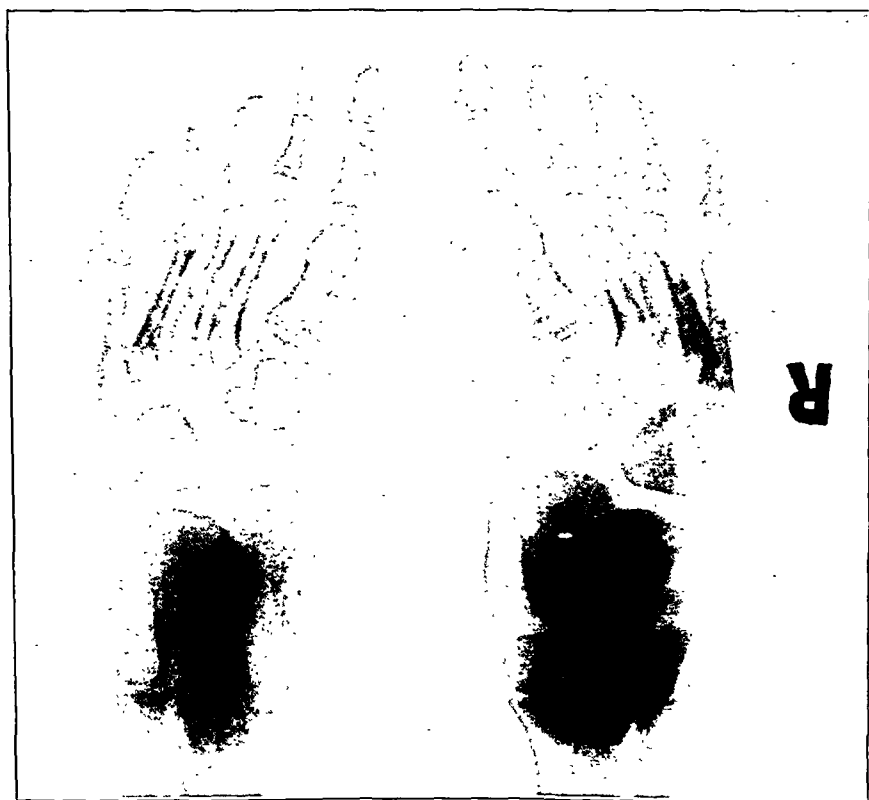


FIG. 11

CASE 4. Betty G. Note relations of astragalus to calcaneus and mild grade of true metatarsus varus as indicated by slight curving of middle metatarsals.

CASE 2. Alice D., aged three and a half, (Children's Hospital of Michigan, No. 66606) registered August 29, 1929, with history of deformity noticed before walking began, but increasing with use. It was described as a turning in of the forefoot only, from the beginning (Fig. 6). No treatment had been given. On examination the feet

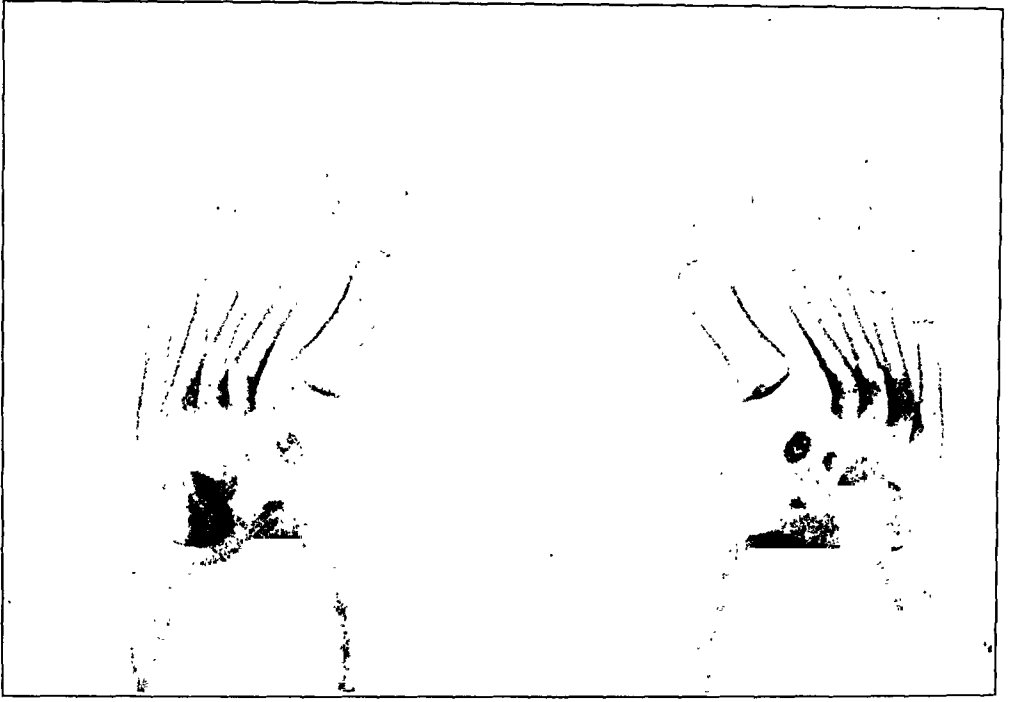


FIG. 12

Case 5. Bernice A. True metatarsus varus, moderate grade.

could be placed in contact with the floor throughout, but the rear part was in a position of marked pronation while the forefoot was both adducted and incurved to an extreme degree. X-ray showed typical high-grade distortions. On September 13, 1929, a capsulotomy (subcutaneous) was done at the base of the first metatarsal and the others were osteotomized subcutaneously. The ensuing manipulation did not accomplish the



FIG. 13

Case 6. Margaret J. Very mild but true metatarsus varus.

desired degree of correction and on September 24 a subcutaneous osteotomy was done on the first metatarsal and on October 4 an open resection of the others. The result was a great improvement functionally and cosmetically, with normal use of shoes, and no complaint on last observation, May 3, 1931. X-rays continued to show characteristic skeletal deformity. Original roentgenograms have been lost and that of Figure 8 is the *final* one.

CASE 3. Robt. R. (Children's Hospital of Michigan, No. 64956) had history of deformity noticed in early months; no difficulty in walking on heels but apparently an increasing toeing-in. He was first observed June 25, 1929, with clinical findings similar to those in Case 1 and Case 2, but somewhat less in degree. X-rays showed typical distortion of moderately high grade. Molding plasters applied without much improvement. On May 16, 1930, a subperiosteal enucleation of the cuboid was done on each foot by one of us (C. W. P.) and the foot wrenched into apparently complete correction. Plasters were continued until July 14, 1930, when x-rays showed considerable diminution of deformity. On last observation feet were quite satisfactory (Figs. 9 and 10).

CASE 4. Betty G., aged four and a half, (Children's Hospital of Michigan, No. 49983) was first observed August 27, 1927, with history of deformity first apparent on walking (Fig. 11). Examination showed no equinus, but posterior tarsal valgus and metatarsus varus. Roentgenograms emphasized clinical findings with astragalus shown markedly displaced and rotated inward, and outer four metatarsals curved in their proximal thirds. On August 30, a subcutaneous fasciotomy and wrenching was done. No subsequent x-rays were obtained, but at the last observation, July 12, 1928, there was noted complete correction of metatarsal varus and considerable residual pronation.

CASE 5. Bernice A., aged two, (Children's Hospital of Michigan, No. 59545) was first observed on February 14, 1929, with history of bilateral foot deformity, first noted on walking. Examination showed no equinus or ankle varus, but marked metatarsus varus. X-rays demonstrated posterior valgus deformity and moderate curving of proximal portions of metatarsal bones and adduction of first (Fig. 12). Corrective plasters were applied but no subsequent observation obtained.

CASE 6. Margaret J., aged one and a half, (Children's Hospital of Michigan, No. 50957) was first observed October 8, 1927, with history of deformity only recently noticed in feet. Examination showed moderate metatarsus varus on left, more marked on right, no equinus. X-rays showed nearly normal posterior tarsal relations on left, and slight supination with outward rotation of astragalus on right, but with definite incurving of metatarsal bones on both sides (Fig. 13). Several manipulations and plasters were carried out with last observation on October 28 recording elimination of metatarsal varus but residual pronation. No additional x-ray examination was obtained.

CASE 7. Frances V., aged eight, (Children's Hospital of Michigan, No. 27056) was first observed on January 12, 1928, with history of intoeing deformity of left foot ever since beginning to walk. At that time was treated by local physician by application of cast;

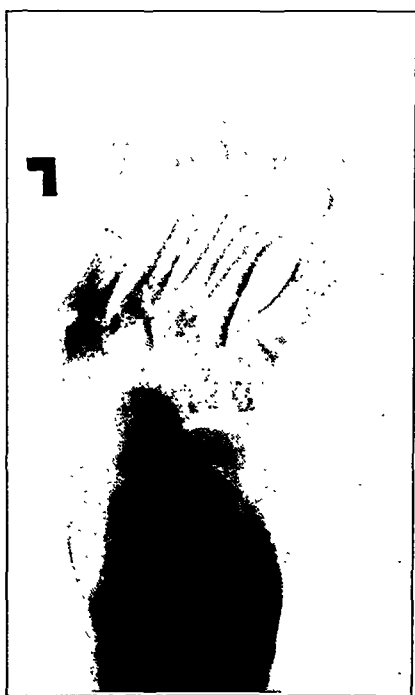


FIG. 14

CASE 7. Francis V. Moderate true varus with ununited fracture of fifth metatarsal.



FIG. 15-A

Case 8. Roentgenogram. Infant with true metatarsus varus, probably high-grade.

had worn outer sole wedge ever since. Six months previous had sustained injury to outer side of foot, with swelling and soreness ever since. Examination indicated marked metatarsus varus and some cavus. X-ray showed curved metatarsal bones and neutral relations in posterior foot (Fig. 14). In addition there seemed to be an ununited fracture in the fifth metatarsal with thickening and sclerosis of this bone. Wassermann test was negative. On January 27, 1928, a fasciotomy and wrenching was done, with last observation on February 2, 1929, recording a good result, but no x-ray check was made.

CASE 8. Baby F., aged six weeks, (Children's Hospital of Michigan, No. 82666) was first observed May 6, 1931, with story of inturning forefoot, bilateral, noticed since birth. On examination feet at first suggested congenital talipes equinovarus; but closer observation determined absence of equinus or ankle varus, but sharp metatarsal



FIG. 15-B

Case 8. Roentgenogram six months later. No treatment in the meantime.



FIG. 16

Case 9. Foster C. Typical adductus.

varus. X-rays emphasized this with the findings of markedly incurved metatarsals (Figs. 15-A and 15-B). In the original films the posterior tarsal relationship could be made out to be that of valgus or pronation. No further observation was obtained in this case.

CASE 9. Foster C., aged two, (Children's Hospital of Michigan, No. 53481) was

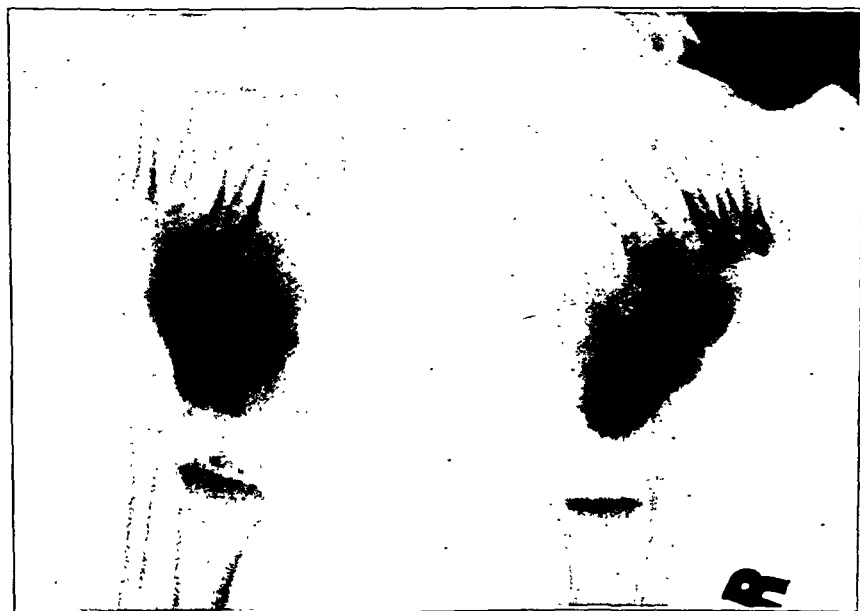


FIG. 17

Case 10. Typical adductus.

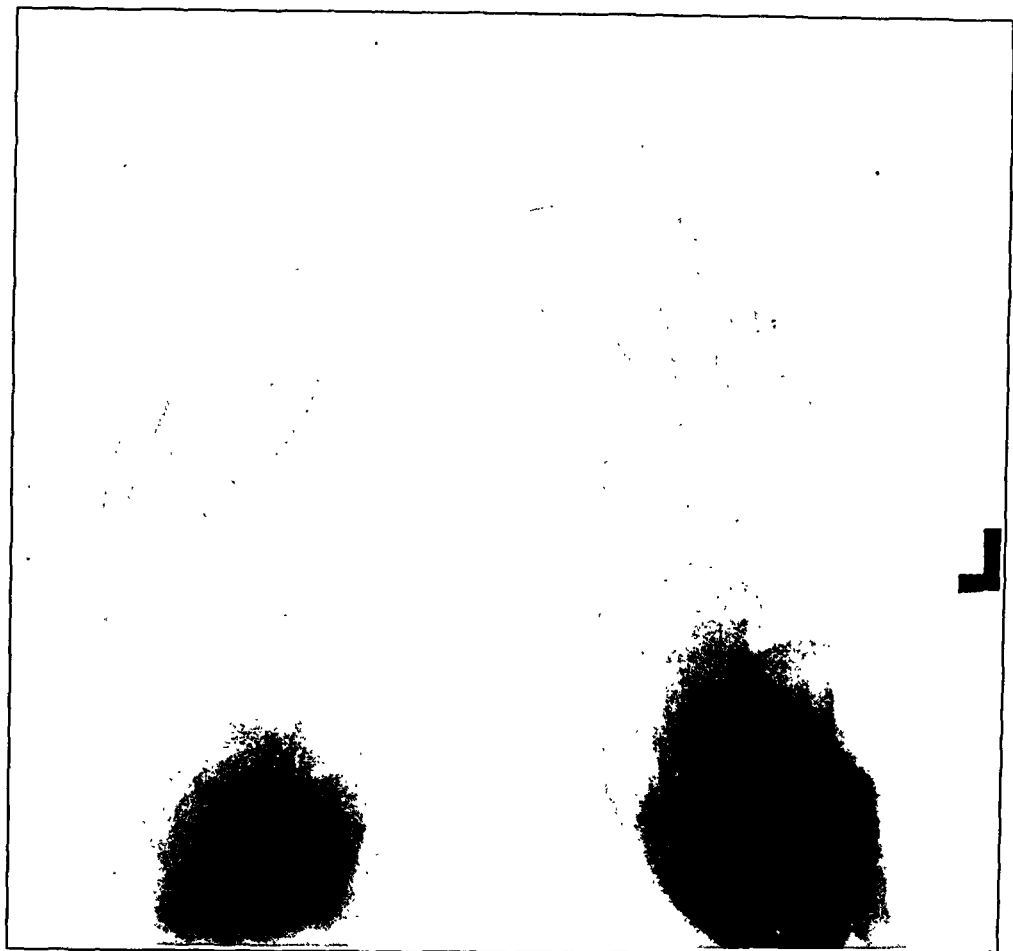


FIG. 18

Case 15. Wm. E. Primary right congenital talipes equinovarus with usual treatment, but residual findings resembling true metatarsus varus.

first observed February 9, 1928, with history of intoeing deformity, right, noted since birth. No previous treatment; never walked on ball of foot only. Examination showed no apparent deformity save metatarsal varus. X-ray showed marked pronation and inward rotation of astragalus on both sides, with considerable adduction deformity of metatarsus on right, but no incurving of individual bones (Fig. 16). No treatment was permitted. This case was classified as metatarsus adductus.

CASE 10. Junior R., aged two, (Children's Hospital of Michigan, No. 67355) was first observed on October 8, 1927, with story of deformity of right foot, first noticed on walking. Examination noted finding of pure metatarsal varus. X-ray indicated posterior tarsal valgus on both sides with sharp adduction of metatarsus on right, no curving of metatarsals (Fig. 17). A wrenching was done and plaster applied, with apparent improvement but no subsequent observation. Case classified as metatarsus adductus.

CASE 11. Mary L., aged two, (Children's Hospital of Michigan, No. 39469) was first observed on June 19, 1926, with story of deformity of right foot noticed on walking; no treatment. Examination notes described moderate varus deformity at metatarsus, no other variation. Treated by molding plaster with good result recorded on last observation, December 27, 1926. No x-rays obtained.

CASE 12. Billy E., aged six, (Children's Hospital of Michigan, No. 56071) was first observed on May 17, 1928, for intoeing deformity of right foot not previously treated. Examination findings note "typical metatarsus varus". No subsequent observation was made.

CASE 13. Vivian A., aged two, (Children's Hospital of Michigan, No. 61528) was observed on January 22, 1929, on account of intoeing of both feet, first noted on walking; no treatment. Examination notes indicated bilateral pronation and bilateral sharp metatarsus varus. No subsequent observation and no x-rays were obtained.

CASE 14. James S., aged seven, (Children's Hospital of Michigan, No. 63490) was observed on April 28, 1929, on account of intoeing deformity of right foot noted since birth. There had been no treatment. Boy had always been able to get heel down. Examination findings include tarsal valgus and metatarsal varus. No subsequent observation.

CASE 15. Wm. E., aged eight, private case, came for observation on account of persisting intoeing of right foot. Examination showed moderate metatarsal varus and tarsal valgus, x-rays showing considerable incurving of metatarsal bones, and the general picture of the primary congenital deformity being discussed. However, the history was very definite for a primary typical congenital talipes equinovarus for which treatment was initiated at three months and included successive molding plasters and final manipulation under anaesthesia. The case is reported to indicate that moderate typical metatarsus varus may be associated with, and residual from, ordinary congenital club-foot, and, in classifying mild cases, the history of original deformity and treatment must be utilized to establish the propriety of diagnosis of primary congenital metatarsus varus.

#### SUMMARY AND CONCLUSIONS

A study has been made of the pathological character and, in most instances, of the response to treatment of fourteen cases of a congenital foot deformity, apparently to be recognized as a definite clinical entity, distinct from talipes equinovarus, yet one which is almost devoid of consideration in text and literature in the English language. The European Continental literature of the last twenty-five years was found to contain quite numerous references and case reports of this condition, including some of distinct value in the study and treatment thereof. Our analyses emphasize a dual nature of the skeletal deformity, and its marked resistance to complete correction. The general type of deformity may be properly subdivided into metatarsus adductus and metatarsus varus. In the former, satisfactory results can be expected from molding in plaster only. In the latter only milder grades are likely to respond to this technique, with the necessity of open intervention quite necessary for the more severe grades. In the latter, a muscle imbalance on a congenital basis may well be looked for, as illustrated by operative findings reported herein. The deformity is not well evaluated in most cases till after the first year and is more satisfactorily treated in ensuing years.

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# PAGET'S OSTEITIS DEFORMANS IN RELATION TO CARDIOVASCULAR DISEASE \*

BY SYDNEY M. CONE, A.B., M.D., F.A.C.S., PIKESVILLE, MARYLAND

Clinical observations, coupled with the pathological findings in more than 900 autopsies convince me that Paget's osteitis deformans is the result of chronic cardiovascular disease. It is the outcome of long continued, intermittent high and low pressure, coupled with changes in organs of internal secretion so commonly accompanying cardiovascular disease. It is the result of the pathological, mechanical action of cardiovascular force long continued on tissues imprisoned by a dense encapsulated cortical bone and periosteum. This is encouraged by the internal secretions called on by bone changes already started by the trauma, minute but constant. The bone changes are more severe where the pituitary, thyroid, or parathyroid glands are independently diseased. It is only after years of bone changes that static conditions produce the more characteristic curves and deformities by which we clinically diagnose the disease.

Of 112 cardiovascular cases seen at autopsy, all show severe bone pathology. The changes in all are varying degrees of those seen in the three most affected, osteitis deformans.

The most marked cases are in three old men, two of whom had, during life, evidenced the alteration of bone structure by the typical bending and distortion of Paget's osteitis deformans, as the cases had been diagnosed. The bones evidence osteoporosis, widened coalescent haversian canals, osteogenesis, erratic architecture, passive congestion, oedema, hemorrhage, pigmentation, fibrosis, cellular hyperplasia, giant cells, clefts containing fluid and cells between lamellae, enlarged coalescent bone lacunae, and enlarged dividing bone cells, myxomatous, fatty, or very cellular marrow and cysts. These three cases of Paget's disease differ much in the amount and location of their alterations. In the same case the bones are variously changed and in different parts of the same bone the pathology varies. The amount of vascular change in the bones also varies greatly. One of the cases was not diagnosed Paget's osteitis deformans during life, but this man also had the bowing of bones and gave the microscopic picture of osteitis deformans. He came in with cardiovascular lesions and apoplexy.

The other 109 cases are in individuals varying in age from seventeen years to eighty years. Each had been the subject of cardiovascular disease for a long time. Disease of heart musculature is quite common, valvular disease most usual, and arteriosclerosis invariable.

The most striking change in the bones of these 109 cases is the passive congestion, oedema, widened coalescent haversian canals, and irregular, "erratic" architecture. This irregularity consists of increase in the number of haversian lamellar systems, unsystematically bounded, and with tortuous individual lamellae. The cortex is commonly narrowed. The

\* From the Pathological Laboratory of the University of Maryland.

trabeculae show absorption by cells or fluid (vital). Their lamellae are widened and separated by fluid which often contains marrow cells. The marrow is cellular, with mostly large cells. These are often massed in areas. Not infrequently fibrosis of the marrow is seen. Osteofibrosis is not infrequent. Osteoblasts not uncommonly border trabeculae of the marrow and line the haversian canals. In the cases where there is a history of old syphilis or thyroid activity, there is invariably evidence of greater activity in bone production.

Some of the older cases are not to be distinguished from Paget's disease except by the lack of excessive architectural changes and greater amount of cell changes.

In examining the bone sections, the alterations are so striking that I label them "Like Paget's" and on looking up the clinical history find invariably that the history is of long-standing cardiovascular disease.

Looking through the description of Sir James Paget's cases, I find evidence of cardiovascular disease in most of them. His first case had severe arteriosclerosis, diseased mitral valves, and "the heart was thin-walled". One case was described as having vertigo and shortness of breath, and one died of valvular heart disease and Bright's disease. In one, the valves of the heart were found diseased. One had congestion of the brain for four years, one had "old syphilis", and another had old rheumatoid disease. Although Sir James in his *Surgical Pathology* refers to the specific action of the circulation in the disease of bone, and although his and Butlin's descriptions evidence severe vascular changes in the bones, he did not mention it as an etiological factor in osteitis deformans, but put it down as "a chronic inflammation of bone".

Many of the cases described in the literature were in persons with cardiovascular disease. Two of Hurwitz's cases were found in the "heart-case" wards. Syphilis and arteriosclerosis, often given as the cause of osteitis deformans, may be responsible through the attendant circulatory disturbances.

The pathology as seen in this generalized process has also been described by me and others as a localized lesion due to trauma.

It appears to me that leontiasis ossea, described in the literature as an independent entity or as an early manifestation of Paget's osteitis deformans, points to circulatory disturbance as the cause of the bone pathology.

We have the same bone changes localized or as a part of a generalized disease<sup>8</sup>. In three cases of brain tumor and in one case of chronic tuberculosis in my collection, I found leontiasis ossea. In these cases there was unusual passive congestion and oedema. That an infection could act as the initial trauma modifying the vascular pathology is not to be denied.

I described a case due to a gunshot wound at the upper extremity of the femur<sup>3</sup>. Sir James Paget referred to Czerny's case of localized osteitis deformans.

Many of the changes seen in these bones have been described by me in localized vascular pathology<sup>5,6</sup>. In "Activities of Bone Cells"<sup>4</sup> is given the circulatory pathology (chronic passive congestion, oedema, and

hemorrhage) a prominent part in the causation of their changes. I have referred to the part the circulatory system plays—both physical and cellular—in most of my writings on bone pathology. More recent observations have been reported by Horton<sup>9</sup>, Ollonquist<sup>10</sup>, J. J. Pemberton<sup>11</sup>, and R. Pemberton<sup>12</sup>.

The constant physical altered pressure, even though small, must act as a trauma to bone even more than to soft parts. Here, the mechanical effects of congestion are produced on inelastic tissue encased by a dense cortex and a periosteal sheath. One must not refer all the changes to physics. When once a tissue is altered there is a call on its attending internal secretion for its wants<sup>7</sup>. Not only this but, at autopsy on these cases, we commonly find alterations in glands (pituitary, thyroid, parathyroid, and ovaries) which influence bone physiology and pathology.

In my cardiovascular cases with old thyroid disease, there is noted a greater tendency to osteogenesis. It is noteworthy that where there is a syphilitic history, the tendency to osteogenesis is greater.

In 1908, writing of Bone Pathology in Its Relation to General Pathology<sup>1</sup>, I described the changes in bone in a case not suspected of having heart disease. The diagnosis of a severe heart lesion was made after the microscopic changes in a metatarsal bone, removed for cosmetic reasons, led me to suspect cardiovascular disease, of which he died shortly thereafter. The passive congestion about tumors was considered as instrumental in the hyperplasia of bone in the neighborhood.

References to how local and general circulation change modifies bone are fully made in my various writings on bone. The most complete bibliography is to be found in "Ossifying Hematoma".<sup>6</sup>

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# OSTEITIS TUBERCULOSA MULTIPLEX CYSTICA (JÜNGLING)

REPORT OF A CASE INVOLVING THE LARGER LONG BONES WITH COMPLETE PROOF OF ITS TUBERCULOUS ETIOLOGY. A REVIEW OF THE LITERATURE\* †

BY GUY S. VAN ALSTYNE, M.D., AND G. HOWARD GOWEN, M.D.,  
CHICAGO, ILLINOIS

In 1920 Jüngling reported his observations, begun in 1911, on a cystic condition of bone for which he claimed a tuberculous etiology and which he named at that time "Ostitis Tuberculosa Multiplex Cystica". In 1911 he first noted this affection, involving the phalanges and metacarpals of the hands, as well as the phalanges and metatarsals of the feet. From 1911 to 1919 four cases were observed by him and the following facts noted: the onset is gradual; pain may be present early but is not severe; there is marked cystic degeneration of the bone which is readily demonstrable by roentgenographic examination; there is a tendency for the small cysts to fuse, forming larger cysts; there is a lack of involvement of the periosteum and joints; there may be a lupoid involvement of the skin in the affected area; the histological picture shows epithelioid and lymphocytic cells, rarely giant cells, no caseation, and no tubercle bacilli; guinea-pig inoculation is frequently negative for tuberculosis and, when positive, is slow, requiring several months; the von Pirquet test is usually negative; the course of the disease is slow with a definite tendency toward spontaneous improvement and even recovery.

Until Jüngling's second article in 1928, the most important contribution on this subject had been that of Fleischner, who called attention to the frequent association of lupus pernio and Boeck's sarcoid with cystic changes in the bones analogous to the osteitis tuberculosa multiplex cystica of Jüngling, and attributed to both skin and bone lesions a common tuberculous origin.

Goeckerman assumes a common tuberculous etiology for lupus pernio and Boeck's sarcoid.

Valenti says: "This disease (lupus pernio and Boeck's sarcoid) becomes manifest with the presence on the skin of hemispheric elements varying in size from a small lentil to a small nut; their color is at first rosy, then pale, and in the end brownish; the consistency is soft and the surface is smooth and slightly squamous. Histologically the cutaneous nodules present the aspect of a chronic inflammatory process and consist of follicles with epithelioid cells, of lymphocytes and some giant cells." Kyrle has demonstrated the tubercle bacillus in microscopic sections of sarcoid lesions.

In 1927 Schürer-Waldheim reported one case of osteitis tuberculosa multiplex cystica, involving the fifth metacarpus and extending into the wrist joint.

\* Received for publication May 23, 1932.

† Read before the Chicago Roentgen Society and the Chicago Orthopaedic Club, October 12, 1932.

In 1928 Jüngling published his second monograph. He reported nine cases which had been observed by him over a period of years. He again emphasizes the chronicity of the affection and the tendency toward spontaneous healing. He notes the frequent association of lupus pernio and Boeck's sarcoid. He emphasizes the frequent inability to demonstrate the tubercle bacillus in the tissues, and the difficulty of producing the tuberculous lesions in the guinea pig, and suggests that the tubercle bacillus causing this disease is one of extremely low virulence. He states that the same cystic condition may occur in the internal organs as in the bones, or that the cystic condition in the bones may be associated with typical tuberculous lesions of the internal organs.

In 1928 Mayr reported a case of lupus pernio with cystic changes in the phalanges. Of the fifty-two similar cases collected by him from the literature, forty were in men. He emphasizes, as does Jüngling, the absence of necrosis and sequestration (See Figure 1).

Also in 1928 Hecht reported two cases of osteitis tuberculosa multiplex cystica in the fingers. In one case lupus pernio developed several years after the bone changes were discovered.

In 1929 Casati reported three cases involving the phalanges.

In 1930 Schürer-Waldheim reported a case of osteitis tuberculosa multiplex cystica of the small bones of the hands and feet, associated with lupus pernio of the nose, in a man fifty years of age. The histological pictures of the nasal lesion and of an amputated finger were (with the exception of the bony structures) identical. Both showed many epithelioid cells; there were many giant cells, though fewer in the finger, resembling typical Langhan's giant cells. There was no caseation and no tubercle bacilli were found.

In our examination of the literature, dating from Jüngling's first article in 1920, we have found no instance of osteitis tuberculosa multiplex cystica (or "Cystoides" as Jüngling later called it) reported as occurring in the larger long bones, with the possible exception of Kienböck's work in which he describes similar cystic lesions in the tibiae and femora of children. He classifies these as "multiple cystic periostitis" and "epiphyseal-zone cystic osteomyelitis". His description of these conditions does not closely correspond to Jüngling's picture of osteitis tuberculosa multiplex cystica, nor does he claim that classification for either of them. He states that these lesions are benign, with a tendency toward spontaneous healing, and that they are probably tuberculous in nature, though he offers no proof of this contention.

Such a case, however, has come under our observation which we feel, because of its rarity and because of our definite etiological findings, should be added to the literature.

Mr. H. L. G., aged thirty-two, married, white, native American, a carpenter, served as a mechanic with the American Army in France. He was first seen by one of us \* on

\* Van Alstyne.

252 J. K. Mayr: Zur Kasuistik des Lupus pernio mit Knochenveränderungen.

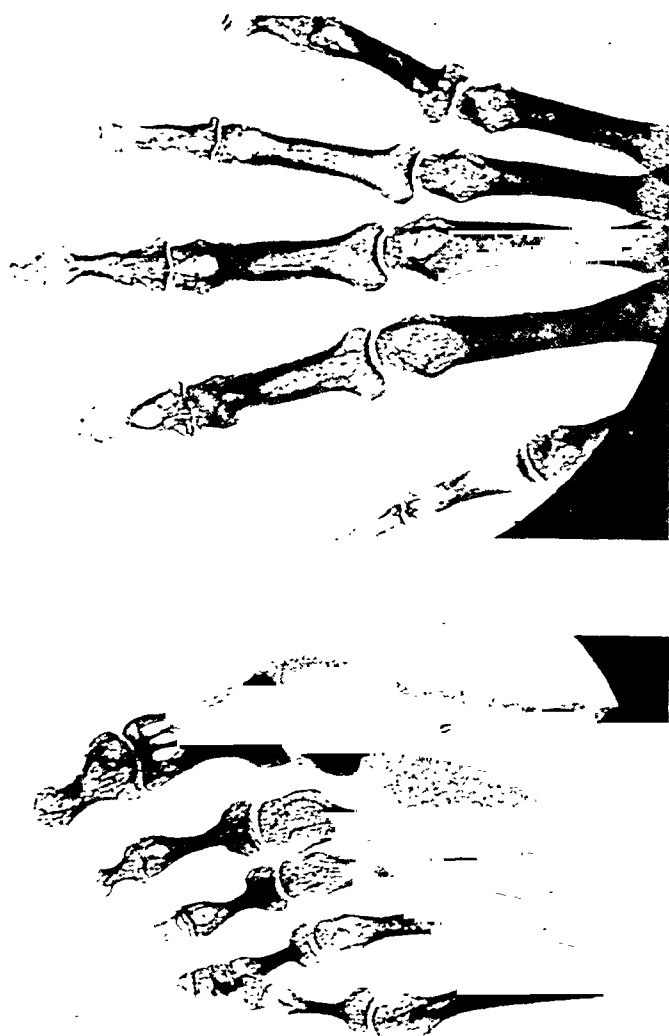


FIG. 1

This cut is reproduced from J. K. Mayr's article: "Zur Kasuistik des Lupus Pernio mit Knochenveränderungen" in *Archiv für Dermatologie und Syphilis* (CLV, 248, 1928), by the kind permission of the publisher, Julius Springer, Berlin.

This roentgenogram is typical of the lesions reported by the other authors mentioned in this report.



April 7, 1931, at which time he complained of (1) swelling and slight pain in the region of the left elbow with limited motion in the joint, and (2) aching and limited motion in the right shoulder.

*Clinical Course:*

Seven years before (1924) he fell four feet, striking his left elbow on a window sill. He continued working, though the elbow felt sore for four or five days. Two months later he ran a splinter of wood into the palm of the left hand near the wrist. This gave no trouble at the time or later; he mentioned that he believed there was still a small piece present. (This is mentioned here as it was considered later as a possible portal of entry of coccidioid infection suggested by Dr. Dick in his roentgenological report.) Two years later (1926) he bumped the same elbow; while playing cards he swung around and struck his "crazy bone" on a chair. The elbow was lame for two or three days following this slight injury. One year later (1927) he noticed a difficulty in extending the left elbow and pain on motion, also an aching in the elbow, especially at night. It would "limber up" and feel all right while at work during the day. He consulted a doctor who had an x-ray taken (Fig. 2), diagnosed the condition "neuritis", and treated it with "violet ray" for one month without benefit. A few months later he saw another doctor who made a diagnosis of "occupational rheumatism and neuritis".

The following year (1928) he consulted Dr. Frank D. Moore \* who ordered an x-ray from which he made the diagnosis of "bone cyst near upper joint of left ulna". (This x-ray film is missing from the records.) Dr. Moore operated at the Garfield Park Hospital on May 23, 1928. His operative record reads: "Incision on the posterior lateral as-

\* Deceased.

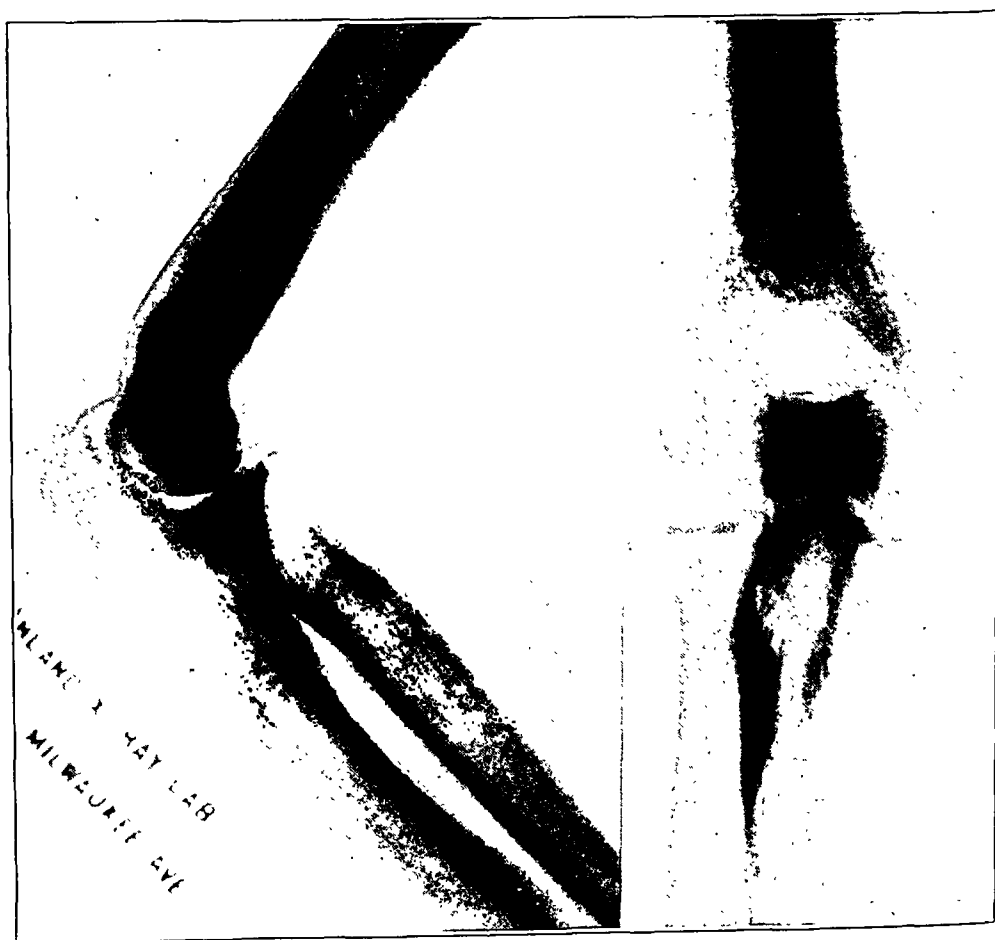


FIG. 2

pect of forearm, upper third; cyst emptied; adhesions broken up, wound closed in layers. Postoperative diagnosis: same." This wound was closed without drainage and healed promptly. After this he was free from pain and lacked only about ten degrees of complete extension at the elbow.

One year later (1929) soft nodules appeared deep in the tissues over the inner condyle of the humerus. He experienced no pain at this time. He again consulted Dr. Moore who had another x-ray taken (Fig. 3). His diagnosis was "bone cyst", and operation was performed on July 10, 1929. The following is taken from the records of the Garfield Park Hospital: "Preoperative diagnosis: bone cyst. Operation: Opened and curetted; closed without drainage. Pathological report (signed by Dr. Paul Schmitt, Pathologist): Periosteal infection, low-grade. No acid-fast bacilli or other micro-organisms were found. A differential count of the cells present shows lymphocytes eighty-six per cent., polymorphonuclear neutrophils fourteen per cent. Microscopic sections of formalin-hardened material show a necrotic tissue. A diagnosis cannot be made, but a tuberculous process should be ruled out by further study (tissue section and guinea-pig inoculation)". Again the incision healed kindly.

In April 1931, when examined, he stated that for the past nine months he had noticed a slowly increasing swelling under the scar of the second incision which was over the

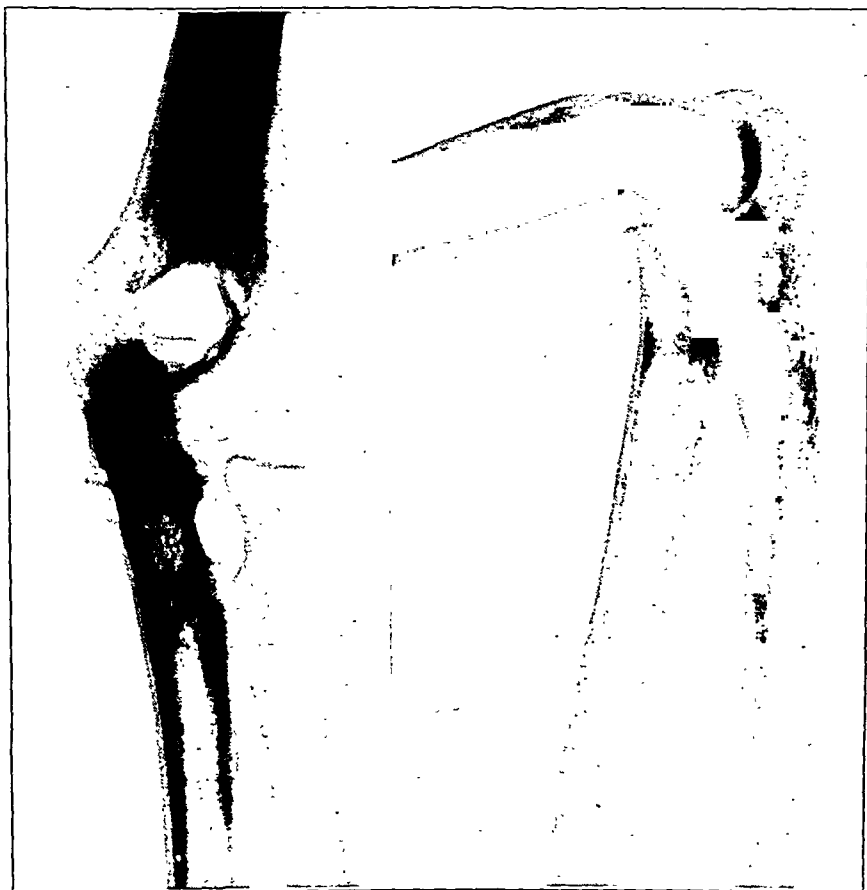


FIG. 3



FIG. 4

lower and mesial aspect of the inner condyle of the left humerus. It was only very slightly tender to touch.

*Past Illnesses:*

He was "gassed" in France in 1918, following which he was blind for three days, spit blood, coughed incessantly for two weeks, and was hospitalized for about three weeks under a diagnosis of "bronchitis and a touch of flu". In 1921 and 1922 he suffered with night sweats, loss of weight, was "nervous", and felt feverish at night. A heart lesion was diagnosed at this time. Until the past few years he had always had a heavy depressed feeling back of his breast bone on damp days. There was no further relevant past history.

*Physical Examination:*

Patient was a well nourished, healthy-appearing young man of about thirty years. The eyes, nose, throat (tonsils absent), ears, neck, lungs, heart, abdomen, and lower extremities were essentially negative. The deep and superficial reflexes were normal. The temperature was normal.

The positive findings were: limited motion in the right shoulder,—the entire shoulder girdle moved freely on the thorax but there was not more than five degrees of motion in the shoulder joint. There was a loss of forty-five degrees of full extension and an equal loss of complete flexion at the left elbow. Two scars of former operations near the left elbow were visible,—one along the upper end of the ulna, and the other on the mesial aspect of the elbow extending upward over the internal condyle of the humerus. Under this second scar was a smooth, rounded, fluctuating, cyst-like tumor, seemingly just beneath

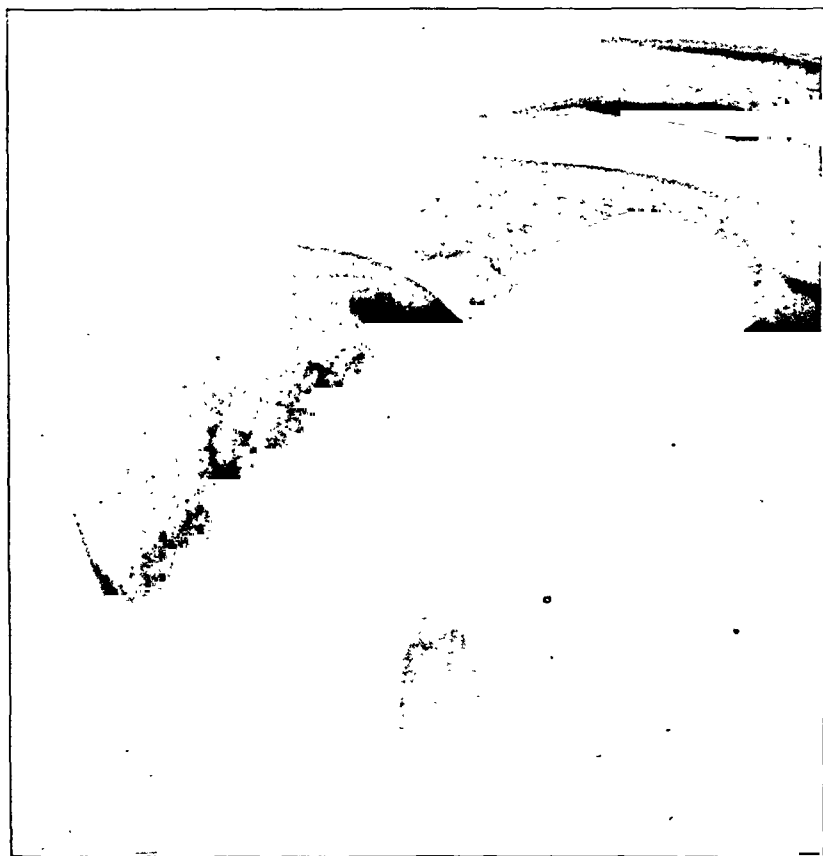


FIG. 5

the skin, about three centimeters in diameter. It was only very slightly tender. Just above it a more elongated and firmer mass could be palpated, situated deeper in the tissues under the triceps. This was about one by three centimeters, and was suggestive of a lymph gland. There was no oedema, redness, or other sign of acute inflammation present in this region. There was a firm body about three-tenths of a centimeter long and the width of a toothpick at the base of his left palm which could well be a small piece of wood splinter located just under the skin. There was no tenderness nor inflammation about it.

*Preoperative Laboratory Findings:*

Blood counts and urine analysis were normal. Blood serum Wassermann and Kahn precipitation tests were negative. A von Pirquet test was faintly positive. Roentgenograms were taken by the National Pathological Laboratory and interpreted by Dr. Paul G. Dick (Figs. 4 and 5). "The shadows representing the bones forming the left elbow present the following departures from normal: in the lower end of the humerus and upper portion of the radius and ulna there are several irregularly rounded shadows of decreased bone density. These do not have the usual transparencies of cysts. The outer portion of the humerus at its articular margin is roughened, and there is evidence of bone destruction in this area which apparently is localized. There is evidence of bone regeneration at the outer margins of the head of the radius and outer lip of the coronoid process of the ulna. There is narrowing of the articulation suggesting destruction of the interarticular cartilage. Just distal to the tip of the olecranon process there are areas of calcification which apparently are in the joint capsule. Shadow densities in the soft tissues are noted

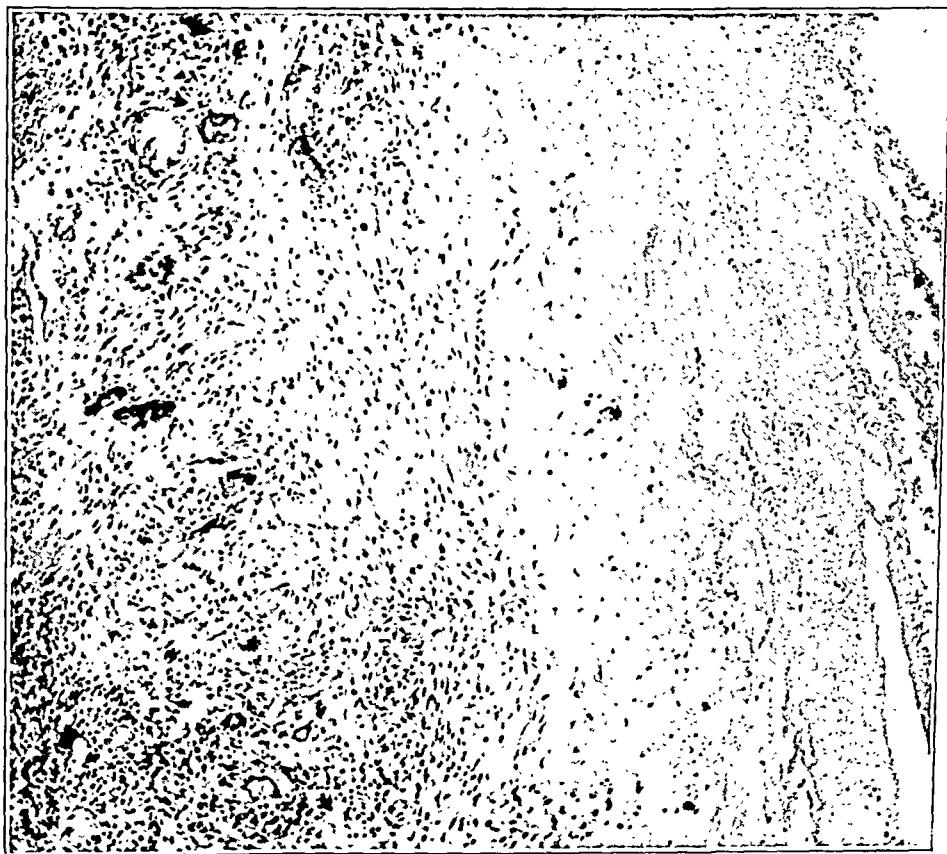


FIG. 6-A

Section of lining membrane of "bone cyst" showing coagulation necrosis with outer layer coat of epithelioid and giant cells.

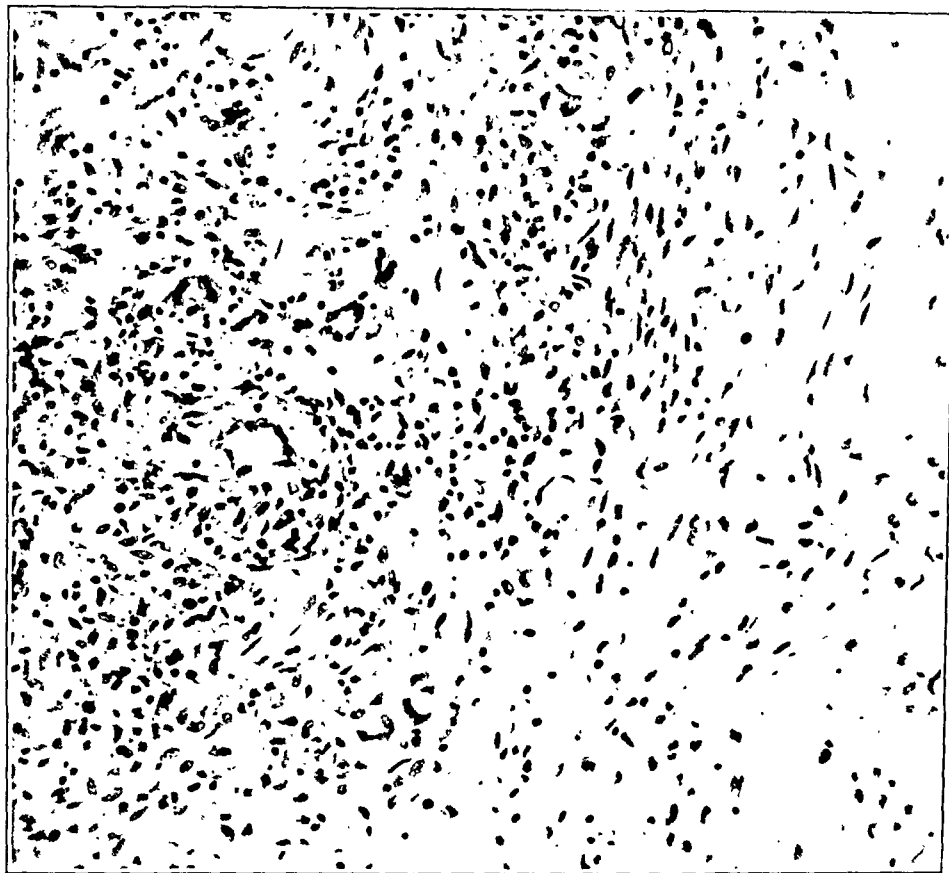


FIG. 6-B

Higher magnification of same, with round, epithelioid, and giant cells in wall of bone cyst.

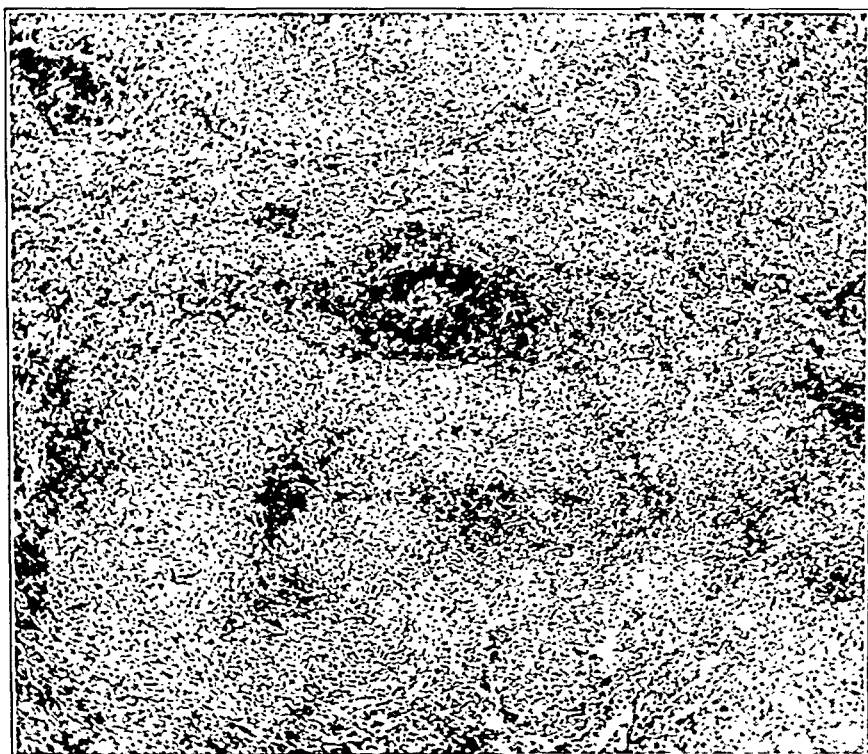


FIG. 8

Section of guinea pig's lymph gland inoculated with fluid from "bone cyst". Note the epithelioid tubercles and giant cells.

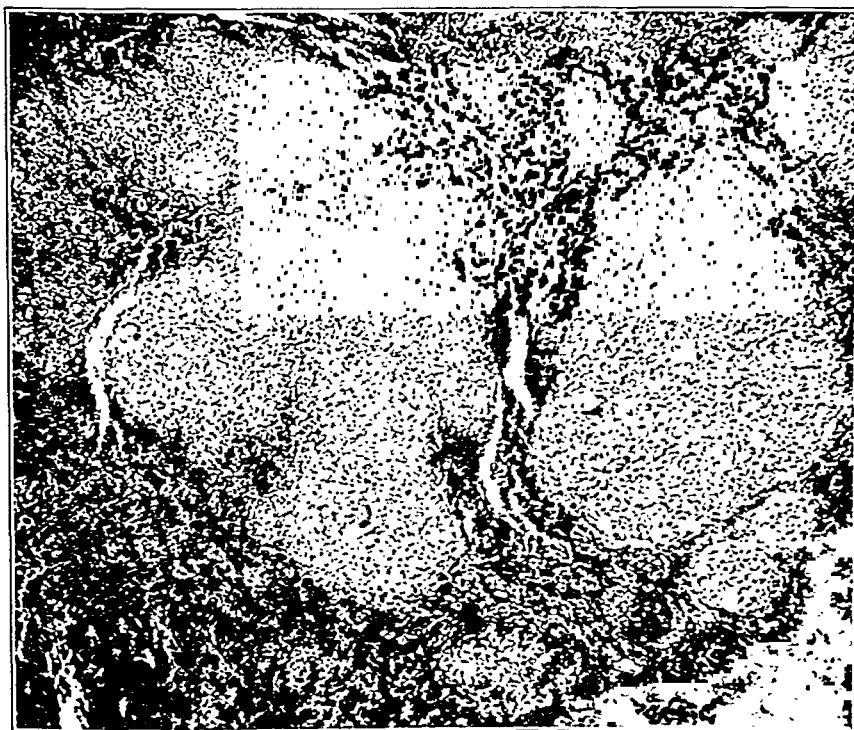


FIG. 7

Lymph gland adjacent to affected elbow, containing typical epithelioid tubercles, with many giant cells.

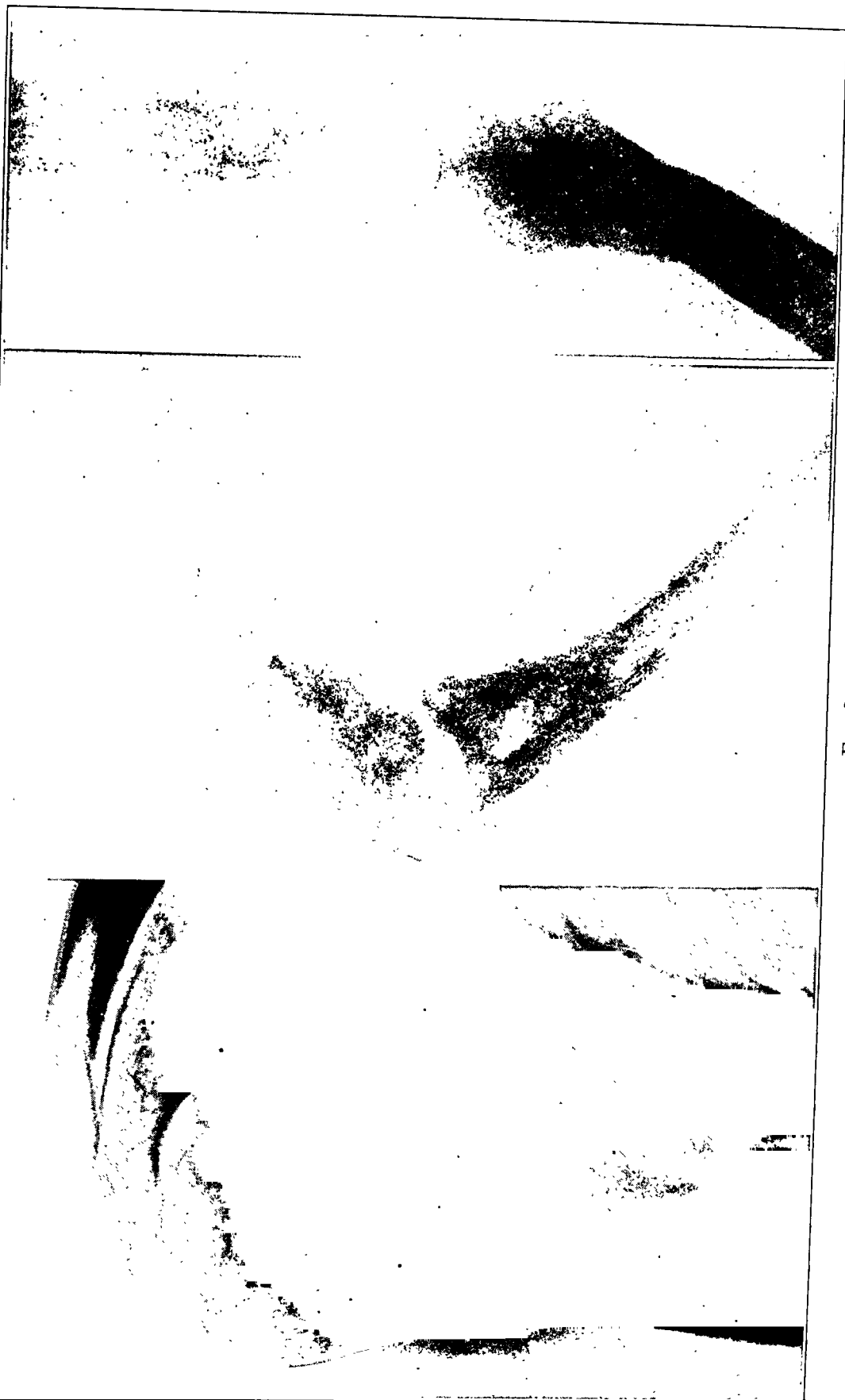


FIG. 9

internal to the head of the radius and external to the condyle of the humerus. There is some periosteal hyperplasia of the lower end of the shaft of the humerus.

"The above described changes do not have the usual features of an osteofibrosis cystica. The periosteal thickening and osteophytic deposits near the articular edges suggest a low-grade inflammatory change. The rounded areas of decreased density could be atypical cyst formation. The possibility of this being a luetic infection is also to be considered. Another condition to be considered is coccidioidal granuloma, if history should indicate this patient to have visited Southern California or other of the southwestern states. This is suggested on account of the soft-tissue changes that are demonstrated. There is no evidence of malignancy.

"In the head of the right humerus there are a number of irregular small areas of decreased bone density which are apparently surrounded by a definite wall and apparently there is no breaking down of the bones surrounding these small areas. They have the appearance of cysts and are quite similar to the condition found in the region of the left elbow. There appears to be destruction of the interarticular cartilage with some roughening of the articulation but there is no evidence of ankylosis. There is no expansion of the cortex. The x-ray evidence would point to a benign condition. There are none of the characteristics of malignancy present. There is no periosteal hyperplasia. The x-ray features, being similar to the shadows in the region of the left elbow, would indicate this condition to be of the same origin."

Fluoroscopic examination and stereoscopic roentgenograms were made of the chest. Dr. Dick's report follows: "The shadows representing both lung fields are apparently clear. There is no evidence of old or recent pulmonary tuberculosis seen in either lung field. In the right lower lung there is a single shadow density which is probably an old focus of infection which is now healed, but I doubt very much whether this is of tuberculous origin. The hilum and intermediate shadows are within normal limits. The pleural margins are clear throughout. There is no evidence of old or recent pleurisy. The size, shape, and position of the heart and aorta conform to the normal. The superior mediastinum is clear."

Dr. W. H. Watterson has made an independent interpretation of these chest films. I quote from his letter: "Stereo study of plate dated April 17, 1931, taken by the National Pathological Laboratory, Chicago, Illinois, No. 37332, shows no evidence of gross pathology in either lung. There is, however, definite evidence of primary foci of Ghon in the right base and careful study reveals that there are densities leading from this on up to the right hilum, in all probability due to the same primary infection, and leaving faint densities, probably fibrous in type, along the root zone of this lung."

In addition, x-rays were taken and reported by Dr. Dick of all of the remaining bones of the patient's body (excepting the skull). These were all entirely negative.

#### *Operation:*

The patient entered Wesley Memorial Hospital on April 14, 1931, and was operated upon the following day under nitrous-oxid anaesthesia for removal of the cyst of the left elbow for further diagnosis. An incision was made over the cyst and an attempt was made to enucleate it from muscle and fascia. This was successful for a distance, but, there being no definite line of cleavage, the cyst eventually ruptured and a quantity of yellowish, thinly gelatinous material was evacuated. The cyst wall was then found to be continuous with a fibrous-like lining of the cavity which appeared in the x-ray in the region of the olecranon fossa. This membrane was thoroughly curetted away and a compact bony wall found underlying, which was in no sense necrotic. No soft nor necrotic bone came away with the curette. The wound was closed without drainage and healed promptly. The regional lymph gland mentioned was then enucleated. The cystic sac, its contents, the curettings, and the lymph gland were carefully preserved for cultural and microscopic examination. A guinea pig was inoculated with the semifluid contents of the cyst.

#### *Postoperative Pathological Reports:*

"*Macroscopic:* This specimen consists of two large remnants of a cyst wall; one is



wedge-shaped, three by two centimeters and three to four millimeters thick, of irregular shape, both of which are composed of bluish-gray to brown fibrous-like tissue with occasional nodules of yellowish fat. There are two masses of 'hazel-nut' sized semigelatinous white tissue and also several 'pea-sized' brownish-gray, friable, fairly firm masses of tissue, in the centers of some of which are firm white nodules.

*"Microscopic:* (1) The cyst wall consists of a chronic granulation tissue containing a few giant cells of the Langhan's type. In places typical tubercles are also present (Figs. 6-A and 6-B). (2) The lymph node is thickly studded with tubercles in which the epithelioid cells are strikingly seen. But little caseation is evident (Fig. 7). Diagnosis: (1) Tuberculosis of bone cyst lining membrane; (2) Regional tuberculous lymphadenitis." (*S. Vaughan, Pathologist for Wesley Memorial Hospital.*)

These sections were also examined by Dr. Bowman C. Crowell, of the American College of Surgeons; Dr. Ludwig Hektoen and Dr. J. J. Moore, of the National Pathological Laboratory; and Dr. J. P. Simonds, of Northwestern University Medical School; all of whom were agreed on the diagnosis of tuberculosis, and also that there was no evidence of a coccidioidal infection.

Report on guinea pig: "Inoculated April 15, 1931; autopsy on May 28, 1931. (1) Direct smears from lymph nodes stained by Ziehl-Neelsen method show many acid-fast bacilli morphologically identical with tubercle bacilli. (2) Microscopic sections of guinea-pig tissues confirm the diagnosis of tuberculosis." (See Figure 8.)

On October 7, 1931, following a day or two of slight pain in the region of the elbow, a small bleb appeared on the most recent scar, similar in appearance to the ordinary "stitch abscess", though lacking any signs of acute inflammation. On opening this bleb a small quantity of a caseous-like material was exuded. A small probe was passed into this opening which proved to be a sinus leading into the cystic cavity in the bone,—the one we had entered at operation. A smear was made of this material with the following report: "The smear shows a moderate number of leukocytes and lymphocytes and a rare acid-fast bacillus, morphologically identical with the tubercle bacillus". (*R. Getty, Bacteriologist, Wesley Memorial Hospital.*)

#### *Treatment:*

Jüngling suggests no definite line of treatment, other than symptomatic; he mentions that wedge-like excisions of the cystic parts may be of value, but does not report having tried this procedure. We consulted Dr. Paul Magnuson for advice as to treatment. He suggested immobilization of both affected regions. This suggestion was followed and the patient's right shoulder and left elbow were immobilized in light aluminum splints until December 1, 1931. The splints were then removed, since by that time practically complete ankylosis had taken place in both joints.

#### *Later Course:*

The general condition of the patient remains satisfactory; he has gained eight pounds in weight; has been fever-free; eats well, and sleeps well. Occasionally he has a neuritic type of pain in the regions of these joints, never persistent nor severe. Early in October, 1931, he complained of neuritic pain in his left wrist and fingers. Roentgenograms were taken at that time which proved negative. The pain persisted only a few days. At the same time x-rays were retaken of the right shoulder and the left elbow, which show no increase in the cystic condition and still show no bone destruction. On the other hand they seem to show some regression as the cystic cavities appear denser than in the earlier pictures. This would conform to the findings of Jüngling and others of spontaneous improvement (Fig. 9).

#### *Prognosis:*

We find no mention in the literature of any case with a fatal termination; instead we find frequent mention of spontaneous improvement and even recovery. If our patient has not improved since coming under our observation he has, at least, not retrogressed. In the light of our present information we are hoping for an eventual recovery.

## CONCLUSIONS

We feel justified, from the history and findings here presented, in placing this case under Jüngling's classification of osteitis tuberculosa multiplex cystica.

We have found no report in the literature of this disease occurring in the larger long bones.

Previous authors have based their claim for a tuberculous etiology on few positive findings or even on indirect evidence. We have been able to fully establish positive proof of its tuberculous nature by: (1) microscopic tubercles in the cyst wall and in a regional lymph gland; (2) tubercle bacilli in the cyst content; (3) microscopic tubercles in the tissues of a guinea pig six weeks after inoculation; (4) tubercle bacilli in the inoculated guinea pig's lymph nodes; with (5) a positive von Pirquet test, (6) marked chronicity from the start, and (7) a very possible preexisting pulmonary tuberculosis.

We wish to express our gratitude and appreciation to the Garfield Park Hospital for furnishing its records; to Dr. Crowell, Dr. Hektoen, Dr. Simonds, Dr. J. J. Moore, and Dr. Watterson for their charitable consultations; to *Archiv für Dermatologie und Syphilis* for kind permission to reproduce Dr. J. K. Mayr's x-ray plates, and especially to Dr. Paul G. Dick for his enthusiastic interest in this case, his many helpful suggestions, and for a series of gratuitous roentgenographic examinations.

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## FRACTURE OF THE CAPITELLUM AND TROCHLEA, COMBINED WITH FRACTURE OF THE EXTERNAL HUMERAL CONDYLE

BY ROBERT C. ROBERTSON, A.B., M.D., AND FRANKLIN B. BOGART, M.S., M.D.,  
CHATTANOOGA, TENNESSEE

Intra-articular fractures of the distal end of the humerus are uncommon. Lindem<sup>1</sup> reviewed the literature in 1922 and found only seventeen cases of fracture of the capitellum, of the trochlea, or of both. They were produced by one of two mechanisms,—a blow on the upper part of the dorsum of the partially flexed forearm, transmitting the force through the articular end of the ulna and the head of the radius to the capitellum and trochlea; or a fall on the hand with the elbow extended, the force being transmitted through the long axis of the radius and ulna to the capitellum and trochlea. When both capitellum and trochlea were involved, they were separated from the humerus *en masse*. Excision of the fragment was given as the treatment of choice. When not reduced or excised, the fragment united to the distal end of the humerus with marked functional disturbance.

Lindem reported three additional cases of fracture of the capitellum and trochlea. In two the etiology was a fall on the hand with the elbow extended; in the other, a fall striking on the posterior surface of the flexed elbow. The cases were seen two, five, and six months, respectively, following fracture. In all, flexion was slight, pronation and supination were normal. In two cases the fragment was freed from the humerus and excised. In one case this resulted in slight improvement after five months; in the other, motion was doubled and pain was absent eight days after operation. The third patient refused operation and was not followed. Fracture through the external condyle was not mentioned by him.

Additional reports of fracture of the capitellum have since appeared.

Eliason, Goldsmith, and Pendergrass in their text<sup>2</sup> show the roentgenogram of a fracture of the capitellum and trochlea.

Homma and Pape<sup>3</sup> first described fractures of the capitellum and trochlea combined with fracture of the external condyle. Two cases were reported by them. The etiology in both was a fall on the flexed elbow. In one, a fracture of the internal epicondyle was also present; in the other, the ulna was displaced laterally on the humerus. The major fragment (capitellum and trochlea) was excised in both cases, with good functional results.

We feel that fractures of this type constitute a distinct clinical entity, and that their apparent rarity warrants the report of additional cases.

CASE 1. S. W. A., Jr., white, student, seventeen years of age. Twelve hours previous to examination on May 30, 1930, while roller-skating, he fell on the extended

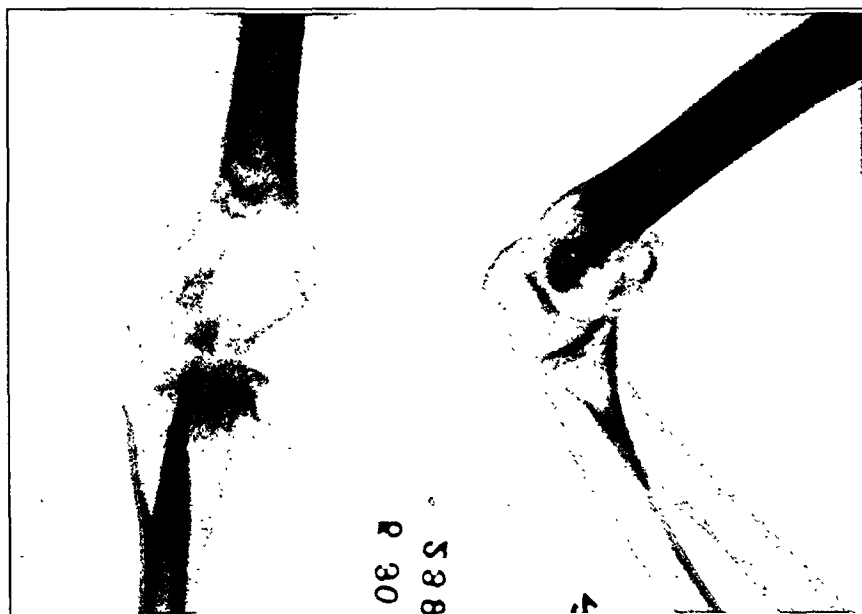


FIG. 1

Case 1. Prior to reduction (May 30, 1930).

left hand with the elbow in hyperextension. There was immediate pain and disability in the elbow, which had grown progressively more marked.

The left elbow was carried in seventy-five degrees' flexion, with forearm midway between pronation and supination. There was moderate swelling of the entire joint area



FIG. 2

Case 1. Nineteen months after reduction (December 14, 1931).

without other gross deformity. Flexion and extension were limited to about fifteen degrees, and were painful. Pronation and supination were quite free. No gross displacement or bony masses were palpable. Crepitus was not obtained.

A lateral roentgenogram revealed a vertical fracture extending through the capitulum and trochlea, with slight upward and forward displacement of the fragment. An anterior-posterior plate confirmed the upward displacement of the major fragment, and revealed an oblique line of fracture extending through the external condyle into the joint, with very slight lateral displacement. Fusion was incomplete in the epiphyses of the medial epicondyle, the radial head, and the olecranon.

With nitrous oxid anaesthesia, reduction was easily obtained under the fluoroscope by gentle hyperextension, accompanied by downward digital pressure in the cubital space, followed by full flexion and fixation in Jones's position. Active motion was instituted on the tenth day; a short sling was applied on the sixteenth; and light weight carrying began on the twenty-ninth. Normal range of painless motion was present two months following injury.

The patient was last seen on December 14, 1931. The injured elbow could not be identified on physical examination. There had been no pain or other disability. Roentgenograms on this date showed a normal relation between all the bony structures which help to form the elbow joint. The fractures were firmly united and there was no excess of callus.

CASE 2: R. S., white, male, farmer, seventeen years of age, was examined on July 3, 1930. While running through the woods two days previously he fell on the extended left hand with the elbow in extension. There was immediate pain and disability in the elbow, soon followed by swelling. Manipulation with ether anaesthesia under the fluoroscope by another surgeon, about eight hours following the accident, and again on the following day, had not reduced the fracture. The patient was then referred for treatment.

The entire elbow area, forearm, and hand were markedly swollen and oedematous. The elbow was held in 100 degrees' flexion by an adhesive strip. Flexion and extension were limited to about fifteen degrees. Pronation and supination were present through an arc of thirty degrees. Dorsiflexion of the wrist was absent. There was no other evidence of nerve lesion. No gross displacement or bony masses were palpable. No crepitus was obtained.



FIG. 3

Case 2. Prior to attempted reduction (July 3, 1930).



FIG. 4

Case 2. Twenty months after failure of closed reduction (March 1, 1932).

A lateral roentgenogram revealed a vertical line of fracture separating the capitellum and trochlea from the humerus, with marked upward and slight forward displacement of this fragment. There were two small fragments immediately distal to the olecranon. The epiphyses of the olecranon and the radial head were not completely fused. On anteroposterior view the upward displacement of the major fragment was confirmed, and an oblique fracture of the external condyle extending into the joint, with slight outward and downward displacement of the fragment, was seen. The epiphysis of the internal epicondyle was not completely fused. Comparison with the original plates showed that the attempts made at reduction on the previous days had displaced the anterior fragment farther upward.

Under ether anaesthesia, reduction under the fluoroscope was attempted by gentle hyperextension combined with downward digital pressure in the cubital space, followed by flexion. This was unsuccessful. On hyperextending the elbow, the lateral edge of the fragment could be replaced, but the balance of the fragment resisted reduction, its bony axis being obliquely displaced upward and medially.

Excision of the fragment was advised and refused. A molded plaster splint was applied with the elbow in seventy-five degrees' flexion. The patient left the hospital two days later and refused to return for observation until March 1, 1932, on which date he stated that he had removed the plaster splint "about a week" after leaving the hospital. He complained of pain only on active use of the extremity.

The entire extremity was moderately atrophic. The elbow was carried in eighty degrees' flexion, with the forearm in pronation. No nerve or circulatory disturbance was present. Active flexion-extension and pronation-supination were limited to ten degrees. All motion was accompanied by slight crepitus. A firm mass was palpable in the cubital space.

Roentgen examination revealed a mass of callus in the cubital space which had been thrown down at the site of the old fracture of the capitellum and trochlea with a marked deformity in the articulating surface. This callus in the cubital space had a cystic appearance.

Excision of the bone mass was advised and refused.

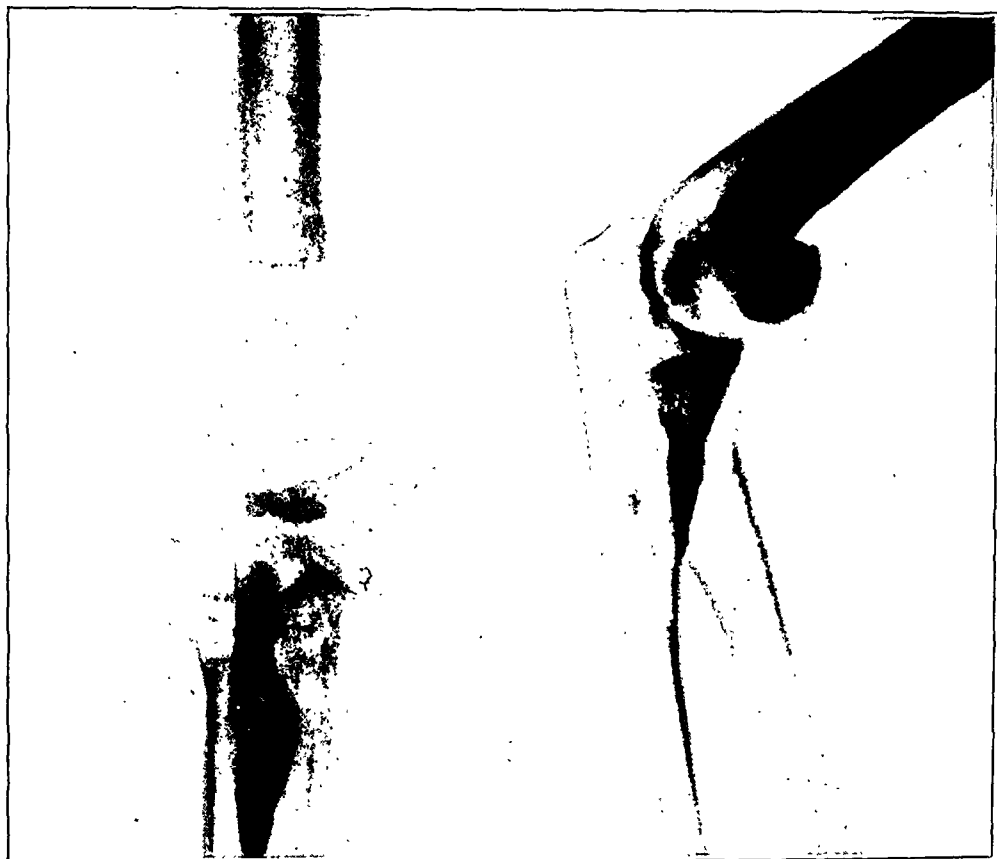


FIG. 5

Case 3. Prior to reduction (April 17, 1931).

CASE 3. Mrs. W. H., white, housewife, twenty-four years of age. On April 17, 1931, while crossing a street, she fell forward on the outstretched hands with both elbows in extension. There was immediate severe pain and disability in the right elbow. This was treated by home remedies until April 21 when a physician was consulted, who, after roentgen examination, attempted reduction under the fluoroscope with ether anaesthesia. This was unsuccessful. She was referred on the following day.

The elbow was carried in a sling in ninety degrees' flexion, with forearm midway between pronation and supination. There was slight periarticular swelling. Flexion and extension were limited to thirty degrees. Pronation and supination were slightly limited. No masses were palpable. No crepitus was obtained.

Roentgenograms revealed on lateral view a vertical fracture through the capitellum and trochlea with marked upward displacement of the anterior fragment. Comparison with the previous plates revealed this displacement to be less than prior to manipulation on the previous day. On anteroposterior view, upward displacement of this fragment was seen, as well as an oblique fracture through the external condyle, extending into the joint, with slight downward displacement of the lateral fragment. Under ether anaesthesia, reduction was easily accomplished under the fluoroscope by gentle hyperextension accompanied by downward digital pressure in the cubital space, followed by acute flexion and fixation in Jones's position. Active motion was started on the tenth day; a sling was applied on the twenty-first day and continued for three weeks. Three weeks after discarding the sling the range of flexion was 80—135 degrees, with full supination and pronation. Daily diathermy, massage, and supervised active motion were instituted at this time with increase of ten degrees in flexion-extension after ten days' time. No further improvement was obtained in the following three weeks, at the end of which time

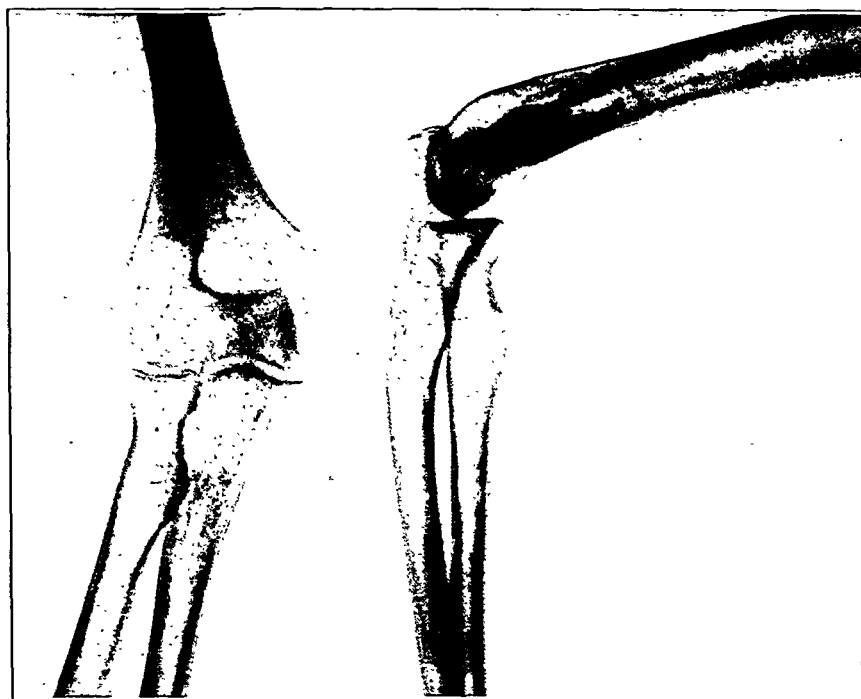


FIG. 6

Case 3. Eight months after reduction (December 12, 1931).

the joint was gently manipulated under general anaesthesia. This resulted in no improvement and was repeated one month later.

Patient was not seen again until four and one-half months after the second manipulation (eight months following reduction). At this time the range of active flexion was 30—135 degrees. Pronation and supination were normal. There was no complaint of pain. Roentgen examination at this time revealed complete healing of the fractures in good position. There was a small mass of callus two by three millimeters at the edge of the joint between the capitellum and the head of the radius.

In an attempt to ascertain the relative frequency of this type of fracture the plates of all elbows x-rayed for possible fracture at Baroness Erlanger Hospital during the period, January, 1922 to April, 1932, and in the private laboratory of one of us (F. B. B.) during the period, March, 1930 to April, 1932, were reviewed with the following findings:

Total number of cases roentgenographed.....	721
Negative for fracture.....	315
<hr/>	
Plates showing fracture.....	406

Of this number there were:

Fracture of radial head.....	181
Fracture of proximal end of ulna.....	46
Fracture of distal end of humerus (including above reported cases).....	179



No additional cases of vertical fracture of the capitellum and trochlea, combined with fracture of the external condyle, were found. Fractures similar in type were as follows:

A. Mrs. L. C., forty-six years of age. Vertical fracture of the capitellum, and fracture through the external condyle with slight upward displacement of both fragments. Etiology not of record. Refused treatment, surgeon in charge unable to follow.

B. Mr. G. R. W., sixteen years of age. Vertical fracture of capitellum and small adjoining portion of trochlea with marked upward displacement of this fragment. Vertical fracture through major portion of trochlea without displacement. Linear fracture through external condyle without displacement. The epiphyses of the radial head, the internal epicondyle, and the olecranon were incompletely fused. Etiology: fall on hand with the elbow in extension. Closed reduction was unsuccessful in our hands, when attempted twelve days after injury. The displaced fragment was removed by one of us (R. C. R.) four days later. Full supination and pronation, but only ten degrees' flexion and extension were obtained.

C. Miss T. D., twenty-four years of age. Vertical fracture of the capitellum and a portion of the trochlea with rotation of the fragment, the articular surface pointing upward. The lateral margin of the radial head (constituting about one-fourth of the circumference of the head) was detached and displaced downward. This fracture resulted from a fall on the extended hand with the elbow in extension. Refused treatment, surgeon in charge unable to follow.

#### DISCUSSION

Vertical fracture of the capitellum and trochlea, combined with fracture of the external humeral condyle, occurred three times in a total of 406 cases of elbow fracture reviewed by us, a percentage of seventy-three one-hundredths.

The etiology in our cases did not apparently differ from that which may produce fracture of the head of the radius, the coronoid process, the capitellum, or the external condyle, or anterior dislocation of the elbow. In children the same mechanism may produce supracondylar fracture or epiphyseal separation. We feel that the exact mechanism of this type of fracture is uncertain.

Although two of our cases had been subjected to manipulation prior to our examination, the striking features in all were: (a) the generalized periarticular swelling without other deformity; (b) freedom of pronation and supination; (c) limitation of flexion and extension; (d) absence of crepitus, and (e) absence of pain on pressure over the radial head. No masses were palpable in the cubital fossa.

Diagnosis was correctly made only by the x-ray.

On roentgen examination, minor fragments were displaced posteriorly in one case. These fragments were small, and apparently detached by the line of fracture extending through the external condyle.

Closed reduction was easily accomplished in two cases. In both it was followed by proven bony union in good position, and good functional results. No difficulty was experienced in maintaining position following reduction. We feel that closed reduction should be attempted in all recent cases of this type, and that in case of failure early excision of the displaced fragment is indicated.

Early active motion does not appear to be contra-indicated.

## CONCLUSIONS

1. Vertical fracture of the capitellum and trochlea *en masse*, combined with oblique fracture of the external condyle, exists as a distinct though uncommon type of elbow fracture.

2. This fracture may be produced by falls on the hand with the elbow extended.

3. Bony union in good position, with good functional results, followed closed reduction in two of our three cases.

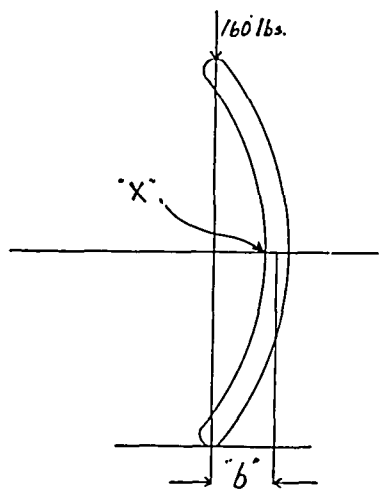
We wish to express our appreciation to Dr. Edwin L. Jenkins, Soddy, Tennessee. Without his cooperation, the late examination of Case 2 could not have been obtained.

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# STRESSES IN A CURVED COLUMN

BY FREMONT A. CHANDLER, M.D., CHICAGO, ILLINOIS



The following table, showing the stresses in a curved column, may be of interest in its application to deformity of the bones of the lower extremities or in malunion of fractures. This table was prepared by an engineer, himself suffering from Paget's disease, and has specific application to an average-sized tibia with bowing. These are purely engineering figures having to do with a vertical load on a column and, of course, do not take into consideration the influence of muscles, ligaments, etc.

A column of round cross section, one and one-half inches in diameter, sixteen inches long, with the ends pivoted (that is, free to turn) carries a load of 160 pounds. The stress of various offsets are shown below:

OFFSET "b" In inches	MAXIMUM STRESS AT "X" <i>Comparison in pounds per square inch</i>	PERCENTAGE OF MAXIMUM STRESS COMPARED TO STRAIGHT-COLUMN STRESS
0 (Straight Column)	130	100
$\frac{1}{4}$	339	261
$\frac{1}{2}$	548	422
$\frac{3}{4}$	757	582
1	966	743
$1\frac{1}{4}$	1175	904
$1\frac{1}{2}$	1384	1065
$1\frac{3}{4}$	1593	1225
2	1802	1386
$2\frac{1}{4}$	2011	1547
$2\frac{1}{2}$	2220	1708
$2\frac{3}{4}$	2429	1868
3	2638	2029
$3\frac{1}{4}$	2847	2190
$3\frac{1}{2}$	3056	2351

You will note that the straight column shows a stress at "X" of 130 pounds per square inch, which was given at 100 per cent. The table then shows the stresses and the percentage of increased stresses for each increment of one-quarter-inch offset. Mathematically it works out that the increase in stress is directly proportional to the offset, so that, with as slight an offset as one-half inch from the straight line, the stress in the case of a man weighing 160 pounds amounts to 548 pounds per square inch, or 422 per cent. as compared with the percentage of 100 for a straight column.

# THE STABILITY OF THE HIP FOLLOWING WHITMAN'S RECONSTRUCTION OPERATION

BY ALBERTO INCLAN, M.D., HAVANA, CUBA  
*Professor of Orthopaedic Surgery, Havana University*

The object in publishing the following cases is to present clinical proof of the stability of a reconstructed hip in which the Whitman method has been employed. A criticism very often made of Whitman's reconstruction operation for non-union with atrophy of the neck of the femur is the tendency toward the luxation of the femoral diaphysis when the limb is brought into adduction. This accident has happened in but one of the writer's cases, and was not due to the operation itself, but to the fact that the postoperative plaster spica holding the limb in full abduction was broken and the leg attained adduction in consequence.

When the trochanter is transplanted at least two inches downward from its normal position, and full abduction is maintained until the trochanter is united to the femoral diaphysis, there is very little possibility of luxation. Two cases in this series of reconstructed hips, using Whitman's technique, have demonstrated the stability of the reconstructed hip. In each case a fall, occurring some time after the operation, resulted in a fracture of the femur, without affecting the area of operation.

The first case may be considered as the worst type for the successful outcome of the above mentioned operation, due to the fact that the

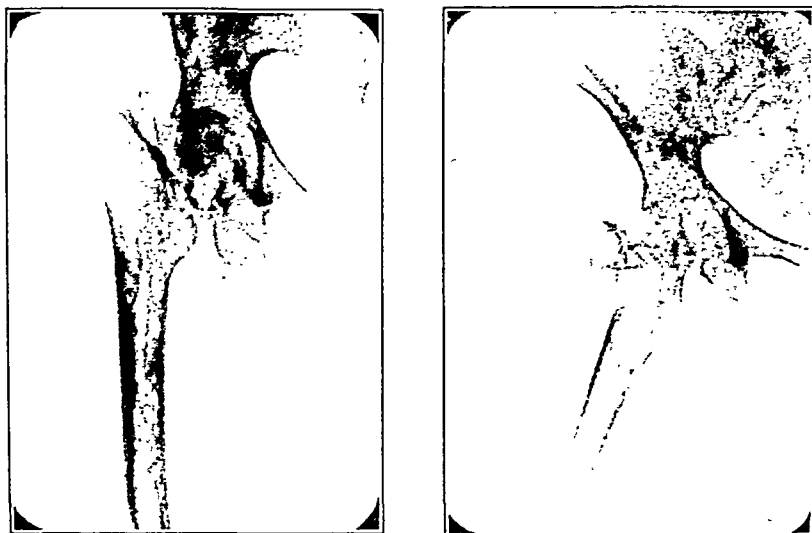


FIG. 1

Original condition and postoperative result following Whitman's reconstruction of the hip. (Courtesy of *Annales de Chirurgia*.)

patient was suffering from a hemiplegia on the affected side, and was operated on eleven months after the neck of the femur had been fractured. In the meantime the limb had been maintained in adduction, flexion, and inward rotation, tenotomies being necessary to correct the deformity and to bring the limb into full abduction at the time of the operation. This patient, while walking with the aid of crutches, two months after leaving the hospital, fell and sustained a supracondylar fracture of the femur. The roentgenographic examination showed that the femur was held in place in the acetabulum in spite of the trauma. Although this patient has never returned for a final examination, and the functional result cannot be reported, we are mentioning it as a proof of the stability of the reconstructed hip.

The second case has been followed more thoroughly and a full report is possible.

CASE 2. C. J., female, white, fifty-eight years of age, was first seen at the Hospital Mercedes on October 4, 1929, ten months after a fracture of the neck of the left femur. There was at that time non-union with partial absorption of the neck of the femur, atrophy of the head, and marked rarefaction of the trabeculae of the femoral diaphysis, shortening of two inches, trochanter well above Nelaton's line, inability to raise the heel from the bed, and complete functional disability,—marked oedema of knee joint with motion of twenty-five degrees. The general condition was fair,—blood pressure normal, no sign of organic disturbance, Wassermann negative.



FIG. 2

Spinal fracture of the femur. Anteroposterior view.



FIG. 3

Spiral fracture of the femur. Lateral view.

*Operation*, November 20, 1929. Regional anaesthesia, epidural and sacral, was used. Whitman's technique was followed and the trochanter was transplanted at least two inches down the femoral diaphysis; there was slight postoperative shock. Immobilization was maintained for forty-five days; the wound healed by first intention. Postoperative roentgenogram shows good union of the trochanter, and the femoral end well maintained in the acetabulum.

After a long period of physiotherapy the patient was able to leave the hospital in September 1930, walking with a cane, without pain, but with flexion at the knee limited to about twenty-five degrees. On

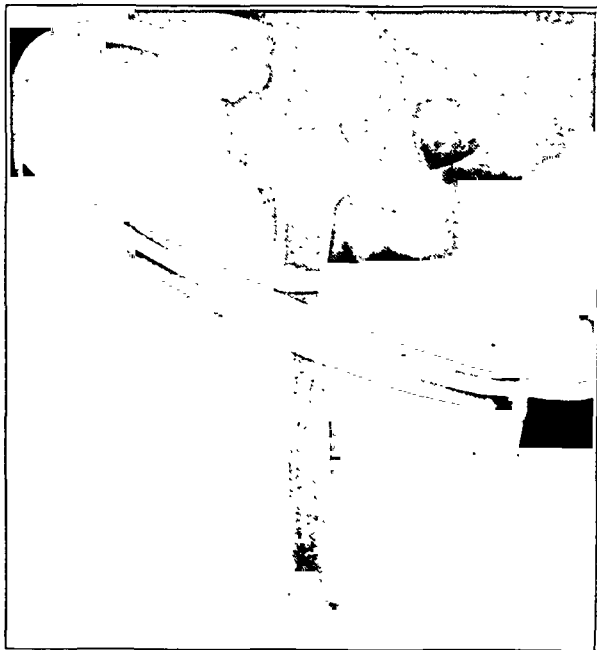


FIG. 4

Osteosynthesis with Putti-Parham bands. Reconstructed hip not disturbed.



FIG. 5

Limb in adduction; solid union; marked adaptational changes at the reconstructed joint.

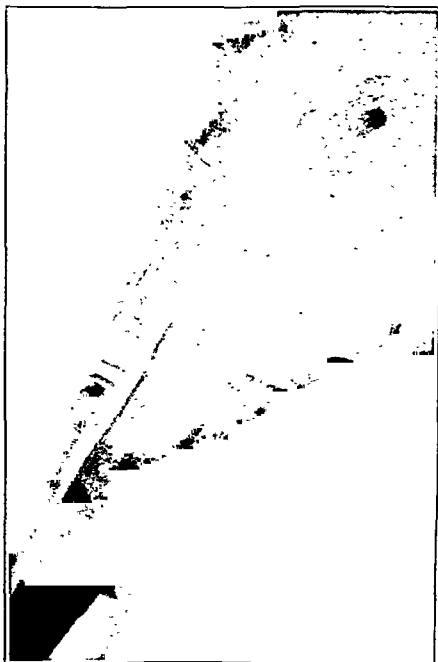


FIG. 6

Limb in abduction, showing leverage obtained after transplantation of trochanter.

November 19, 1930, while walking in her room without the aid of her cane, the patient fell and was unconscious, and, being alone, had no assistance until she recovered consciousness, when she found it impossible to get up. Later she was taken to the hospital. Clinical and roentgenographic examination showed complete spiral fracture of the upper third of the left femur, with three fragments, and with marked displacement and overlapping, but the area of the reconstruction operation, performed just a year before, had not been disturbed.

On account of the line of fracture, the existing displacement, and the difficulty of controlling the intermediate triangular fragment, an open reduction and synthesis were done under spinal anaesthesia on November 26, 1930. Two Putti-Parham bands were used for fixation. Immobilization was maintained in a Thomas splint for six weeks, followed by massage and physiotherapy; walking with crutches was allowed until April 23, when the patient was able to walk with the aid of a cane and was discharged from the hospital.

*Present condition* (May 15, 1932). The patient walks without a cane when performing her household duties, but uses a cane on the street as a precautionary measure, and requires assistance only in fastening the high extension shoe which is worn to compensate for the two inches' shortening resulting from the reconstruction operation. The hip is painless with sufficient active mobility in all directions; the left knee still shows limitation of flexion to forty-five degrees and clinical signs of chronic arthritis. The roentgenographic examination showed marked functional adaptation of the articular surfaces of the reconstructed hip and solid union maintained at the site of the fracture.

In conclusion, it may be added that this case, in which the line of fracture clearly demonstrates the acting forces of torsion and flexion necessary to produce this type of spiral fracture of the femur, and in which the reconstructed joint was submitted to a very severe test, proves satisfactorily the stability obtained by the operation previously performed.

## LENGTHENING OF THE FEMUR WITH SIMULTANEOUS CORRECTION OF COXA VARA

BY SYLVAN L. HAAS, M.D., SAN FRANCISCO, CALIFORNIA

*From the Shriners' Hospital for Crippled Children, San Francisco*

The amount of shortening of the extremity in coxa vara is dependent on the degree of upward displacement of the shaft on the neck of the femur. The loss in length in the ordinary type of coxa vara usually does not exceed one inch, but in cases associated with other influencing factors—as anterior poliomyelitis, malunited fractures, or destructive lesions of the femur—the disparity in length may be much greater.

The restoration of the normal angle of the neck to the shaft is usually accomplished by an osteotomy in the subtrochanteric region of the femur. With the correction of the deformity some lengthening is obtained, but with the various types of osteotomies that have been advocated not more than one-half to three-quarters of an inch gain in length of the femur has been attained. In those patients where there is a shortening of several inches, some other supplementary bone-lengthening operation must be instituted. It appeared probable that if a long intertrochanteric osteotomy was performed and at the same time traction applied in the right direction, the coxa vara could be corrected and lengthening of the femur accomplished at the same time. With this object in view, the following procedure was carried out on two patients.

### PROCEDURE

An incision is made from the greater trochanter downward for about twenty centimeters on the anterior lateral surface of the thigh. The greater trochanter is exposed by peeling back the insertion of the muscles, after which dissection is carried down so as to expose the anterior surface of the shaft to below the level of the lesser trochanter. A long diagonal osteotomy is then outlined, extending from the tip of the greater trochanter downward and inward to below the lesser trochanter. A sharp broad osteotome is used to perform the osteotomy so planned, care being exercised to make sure that the fragments are free. Thus is produced what is really an intertrochanteric fracture with the head, neck, and part of the intertrochanteric region making up the proximal fragment, and the remainder of the femur the distal fragment. By applying the principle usually instituted in the treatment of this type of fracture—namely, traction in abduction and flexion—the angle of the neck can be corrected and the lower fragment pulled down on the proximal to give additional length to the femur. Skeletal traction by means of a pin inserted into the lower end of the femur or upper end of the tibia is necessary to get a sufficiently strong pull to obtain the required increase in length. A brief



résumé of two cases will serve to present some of the details of the procedure and its application.

**PATIENT 1.** Male, aged thirteen years.

*History:* At the age of three years the patient sustained a fracture of the right femur in the subtrochanteric region. A pseudarthrosis, which was unsuccessfully treated by several operations, existed at the time of his admission to the Shriners' Hospital.

*Examination:* There was a pseudarthrosis in the subtrochanteric region of the right femur with coxa vara and about five and one-half inches of shortening (Fig. 1).

*Treatment:* September 8, 1930. Resection of the bone at the site of the pseudarthrosis and implantation of a tibial bone graft. Successful result obtained (Fig. 2).

*Second operation:* January 29, 1932. Resection of one and one-half inches from the normal femur (Fig. 4, left).

*Third operation:* April 9, 1932. Lengthening of the femur and correction of coxa vara. The operation as previously outlined was performed. In Figure 3 can be seen the line of osteotomy. Skeletal traction was obtained by passing a pin through the tibia and fastening cable wires from the pin to the end of a Thomas splint. Direct pull was made on the splint in abduction and flexion with the necessary weights up to thirty-five pounds for the first week. The foot of the bed was raised, using the weight of the patient for countertraction. The weight was decreased to twenty-five pounds during the second week and to fifteen pounds for the third week. At the end of the



FIG. 1

Patient 1. Non-union of nine years' duration with coxa vara. The right leg is five and one-half inches shorter than the left.



FIG. 2

Patient 1. Union of pseudarthrosis after nine years' duration following resection and bone graft. Coxa vara and shortening of five and one-half inches still present.

third week adhesive plaster skin traction was substituted for skeletal traction for four weeks. A plaster spica was then applied for two weeks and, after its removal, exercises in bed were prescribed. The patient was allowed to be up on crutches as soon as his strength permitted, with gradually increasing amounts of weight-bearing on the injured extremity.

*Result:* The coxa vara of the neck of the femur was fairly well corrected and from one and one-half to one and three-quarters inches of lengthening obtained (Fig. 4, right). This increase in length in conjunction with the shortening of the good leg has reduced the disparity in length from five and one-half inches to about one and three-quarters inches at present.

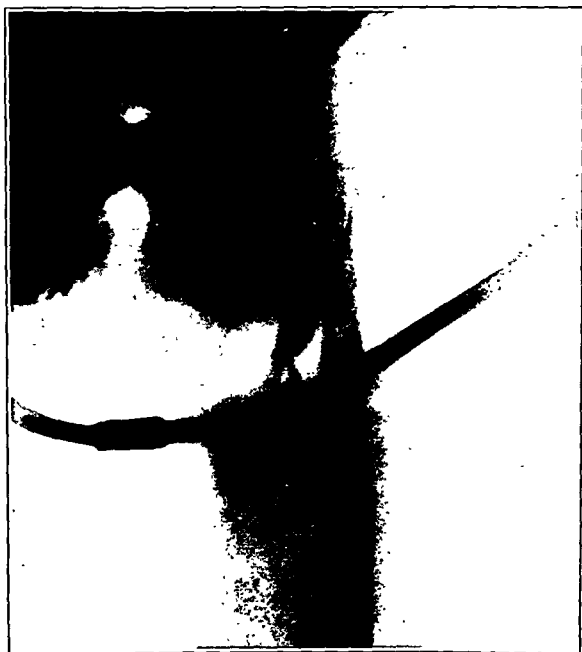


FIG. 3

Patient 1. Shows intertrochanteric osteotomy of femur. Traction was applied after the osteotomy. Note the restoration of the normal angle of the neck with the shaft and pulling down of distal fragment of the femur.



FIG. 4

Patient 1. Final result. Note correction of coxa vara. Length increase of about one and three-quarters inches obtained. Note opposite femur in which there has been a resection of a portion of the shaft to shorten the femur and help equalize the two extremities.



FIG. 5

Patient 2. Coxa vara with two and one-half inches of shortening before operation.

PATIENT 2. Male, aged thirteen years and three months.

*History:* This boy had anterior poliomyelitis at the age of three years, with resultant permanent paralysis of the left extremity.

*Examination:* The left limb is about two and one-half inches shorter than the right and there is a marked coxa vara of the femur (Fig. 5).

*Treatment:* April 27, 1932 an intertrochanteric diagonal osteotomy of the femur was performed as outlined (Fig. 6). A pin was driven through the remainder of the greater trochanter on the proximal fragment to the side of the ilium to fix it in position. A second pin was then driven through the lower end of the femur for skeletal traction which was applied in abduction and flexion for thirty days by means of a Thomas splint similar to that used in the first case. The skeletal traction was supplanted by skin traction for one week, after which a plaster spica was applied to the left extremity until union was complete.

*Result:* The coxa vara was corrected and, at the same time, two and one-half inches in length obtained (Fig. 7).

#### COMMENTS

By the method described it is possible to lengthen the femur and correct the coxa vara at the same time. Although some increase in length is obtained by the correction of the coxa vara, the greater amount is due to the excursion of the distal fragment downward on the proximal fragment.

The correction of the angle between the neck and shaft can be controlled by varying the abduction and flexion of the distal fragment, checking as necessary by roentgenograms.

The tendency for early union is similar to that which takes place routinely in intertrochanteric fractures. Some hesitancy was felt in the first case where there had existed a non-union for nine years in the operative area. Union, however, proceeded without delay.

Skeletal traction may be applied by a pin through the lower end of the femur or upper end of the tibia, the latter being less likely to cause disturbances in the knee joint if the duration of traction is not over four weeks.

This method of lengthening is applicable in securing lengthening even when there is no coexisting coxa vara. The operative procedure is relatively simple and no special apparatus is necessary.



FIG. 6

Patient 2. Showing intertrochanteric osteotomy with pulling down of the distal fragment. Note change in angle of neck.

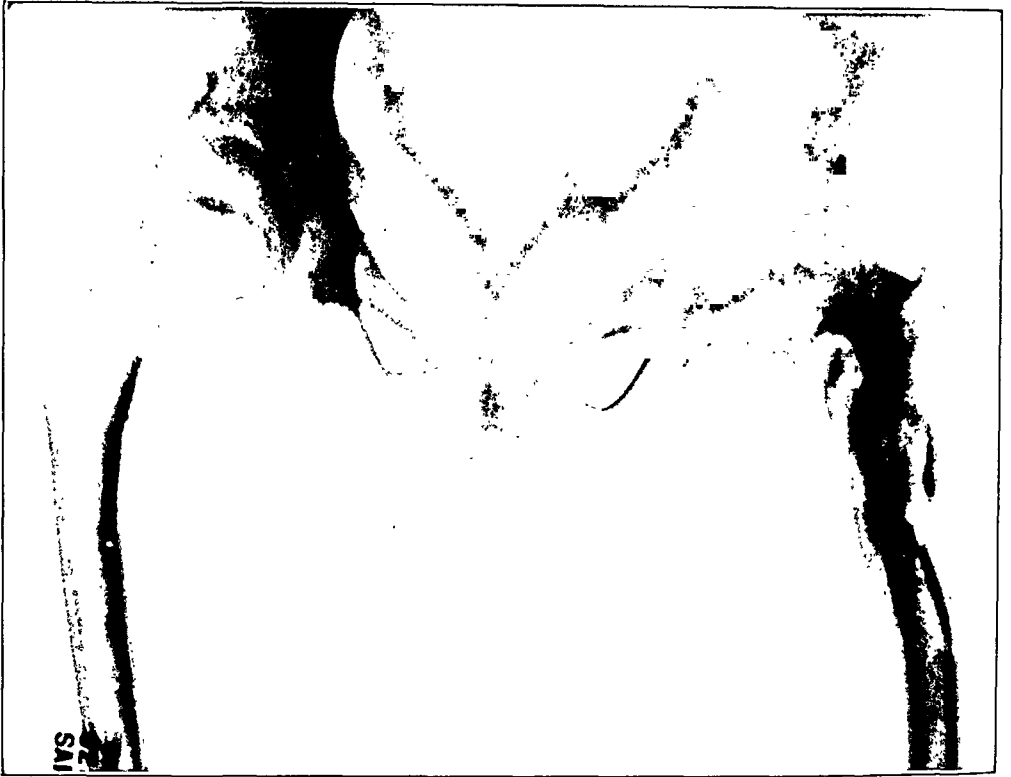


FIG. 7

Patient 2. Final result. Note the correction of coxa vara. In this patient, beside correction of coxa vara, two and one-half inches' increase of length was obtained by this procedure.

#### CONCLUSION

Lengthening of the femur and correction of coxa vara can be simultaneously obtained by making a diagonal osteotomy from the greater to the lesser trochanter and applying skeletal traction to the distal fragment. The correction of the coxa vara can be regulated by the degree of the angle of abduction and flexion. Some of the lengthening is dependent upon the correction of the coxa vara but the greater amount is due to the downward excursion of the distal fragment on the proximal fragment.

## OSTEOCHONDRITIS OF THE INTERNAL CUNEIFORM\*

BY JOSEPH BUCHMAN, B.S., M.D., F.A.C.S., BROOKLYN, NEW YORK

In a recent article <sup>1</sup> the author called attention to the fact that since 1888 a number of writers have described a group of conditions, all of which have more recently been grouped under the generic term of osteochondritis, signifying a non-inflammatory derangement of the normal process of bony growth occurring at the various centers of ossification at the time of their greatest developmental activity. He then listed the various locations in which these affections were found,—namely, the centrum and the superior and inferior epiphyseal regions of the vertebral bodies, the sternal end of the clavicle, the acromion, the coracoid process of the scapula, the head of the humerus, the internal epicondyle of the humerus, the olecranon, the heads of the metacarpal bones, the iliac crests, the pubic bones, the ischial tuberosity, the capital epiphysis of the femur, the epiphyseal cartilage between the head and neck of the femur, the greater and lesser trochanters of the femur, the patella, the upper and lower ends of the tibia, the tibial tubercle, the lower end of the fibula, the astragalus, the apophysis of the os calcis, the base of the fifth metatarsal, the heads of the second and third metatarsal bones, and the sesamoids of the big toe. Since the writing of the above-mentioned article, other foci of this disturbance have been described in the literature. These are the acetabulum <sup>6</sup>, the lower end of the ulna <sup>7</sup>, and the accessory tarsal scaphoid <sup>8</sup>. The purpose of this communication is to present two case reports of still another site, which, to all appearances, has not as yet been described,—namely, an involvement of the internal cuneiform associated with a similar affection of the tarsal scaphoid.

### CASE REPORTS

CASE 1. The patient, a white male, six and a half years old, was seen in the summer of 1930, complaining of pain in the left foot subsequent to a twist of the foot as a result of a misstep. Examination revealed that the general physical status of the child was essentially negative, save that he walked with a limp on the left side. Locally, there was tenderness on the dorsum of the foot in the region of the internal cuneiform. There was no ecchymosis, redness, local heat, or oedema.

Roentgenographic examination of the left foot (Fig. 1) revealed that the internal cuneiform was definitely deformed and much smaller than normal, especially in its longitudinal axis. Its inner two-thirds presented areas of rarefaction and condensation and its outlines were smooth but irregular. The scaphoid was markedly underdeveloped, as is evident from a comparison with a roentgenogram of a normal foot of a child of the same age and sex (Fig. 2), and presented two centers of ossification arranged in a vertical alignment, the dorsal being smaller than the plantar segment. In the dorsoventral view three centers of ossification were visible. The texture of these centers showed areas of apparent rarefaction and condensation. No pathological changes were noted in any of

\* From the Services of Dr. Samuel Kleinberg, Hospital for Joint Diseases, New York, and the United Israel Zion Hospital, Brooklyn, New York; and the First Orthopaedic Division, Hospital for the Ruptured and Crippled, New York.



Fig. 2

Roentgenogram of a normal foot of a boy, six and a half years old, for comparison with Figs. 1 and 3.

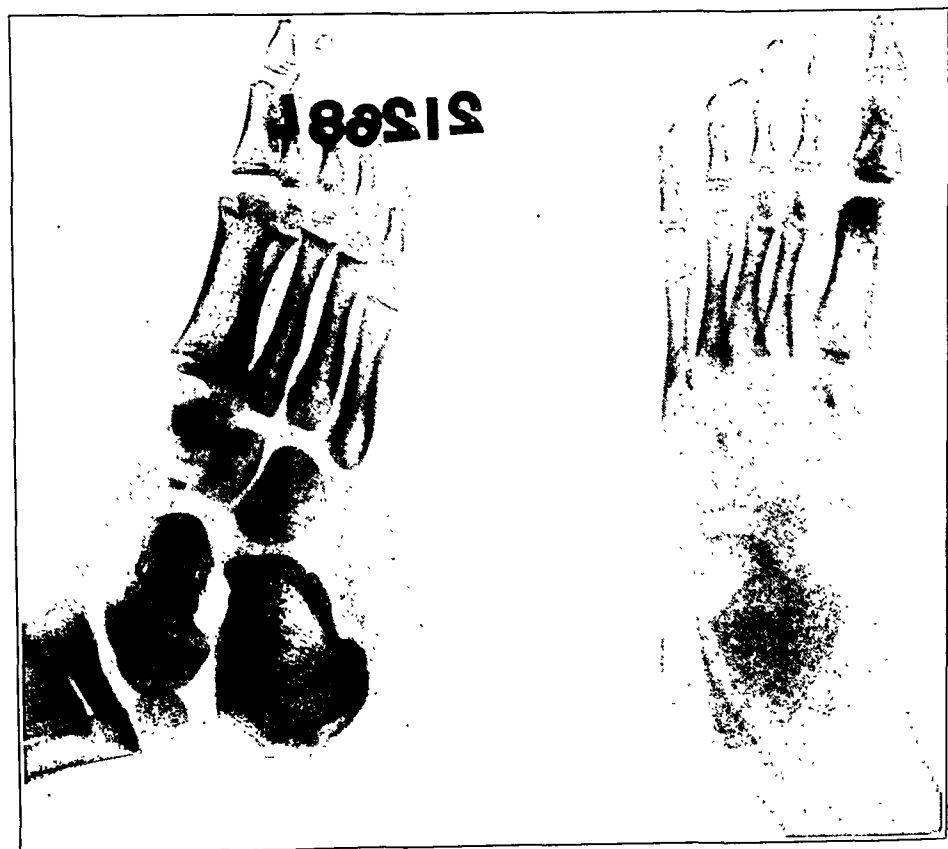


Fig. 1

Case 1. Anteroposterior and lateral views of the left foot, showing the irregularly shaped internal cuneiform, its lessened longitudinal diameter, with areas of condensation and rarefaction. The scaphoid is markedly underdeveloped, and consists of three ossific centers, which present irregularities of calcification.



FIG. 4

Case 1. Anteroposterior and lateral views of the left foot twenty-six months after Fig. 1, showing a diminution in the longitudinal diameter of the scaphoid and of the internal cuneiform. The former still presents changes in calcification, while the latter presents a normal structure. The outline of the scaphoid is irregular.



FIG. 3

Case 1. Roentgenogram of the patient's right foot showing a similar appearance of the internal cuneiform. The scaphoid presents two centers of ossification but no areas of rarefaction or condensation.



the other tarsal bones. Roentgenographic examination of the right foot (Fig. 3) revealed identical changes, with the exception that the scaphoid did not show any changes in calcification, although it presented two centers of ossification.

The patient was treated with adhesive strapping for two weeks and was relieved of his pain. Two years later, the patient was recalled and questioning elicited that the interval history was negative save for the observation by the parents that the child walked with his feet turned out. Physical examination at that time was negative, save for a moderate grade of double weak feet.

A roentgenographic study made twenty-six months subsequent to the previous examination (Fig. 4)—that is, at the age of eight years and eight months—showed that the internal cuneiform is somewhat compressed in its longitudinal diameter. Its structure, however, is practically normal. The scaphoid is also compressed in its longitudinal diameter, and presents several areas of rarefaction and condensation. It is also noted that the outline of the scaphoid is irregular. Examination of the right foot (Fig. 5) shows a similar condition, with the exception that the rarefaction and condensation in the scaphoid is not quite so marked.

CASE 2. The patient, a colored male, six and a half years old, was admitted to the Out-Patient Department of the Hospital for Joint Diseases because of a fracture of the forearm. He had no complaint referable to his feet. Physical examination was negative, save for the local condition in the forearm. He had in addition a mild grade of double weak feet. His right foot was roentgenographed for purposes of comparison with that of Case 1. Much to our surprise, we found a roentgenographic appearance (Fig. 7) similar to that in Case 1. Both the scaphoid and the internal cuneiform presented irregularities in calcification and outline, while their longitudinal diameters were slightly diminished. The patient was lost from sight and a roentgenographic study of the left foot could, therefore, not be made, much to our regret.

#### COMMENT

A consideration of the clinical and roentgenographic findings in the first patient makes it very evident that we are dealing with an instance of the so called osteochondritis of the internal cuneiform of both feet, associated with an alteration in the scaphoid consisting of multiple nuclei of ossification, underdevelopment, and later changes in morphology suggestive of the end result of Köhler's disease. The mild clinical history referable to the left foot, the lack of clinical manifestations of any disturbance in the right foot, the marked roentgenographic changes, the association with the classic disturbance of the scaphoid, the subsequent course and the practically complete reformation of the affected bones, leave little doubt as to the character of the lesions. The second case is very definitely one of osteochondritis of the scaphoid, as shown by the roentgenographic study; the appearance of the cuneiform is so similar that the same diagnosis—namely, osteochondritis—seems reasonable and correct.

A review of the literature on ossification of the internal cuneiform shows that according to Gray, Piersol, Bailey and Miller, and Kreuscher, the center of ossification appears during the third year. Spalteholz notes its appearance during the first year of life. Cohn states that ossification begins at three and one half years of life, while Haret, Dariaux, and Quénu list its appearance at one and one-half to two and one-half years of life. Piersol also notes that very exceptionally the cuneiform



FIG. 6

Roentgenogram of a normal foot of a boy, eight and a half years old, for a comparison with Figs. 4 and 5.

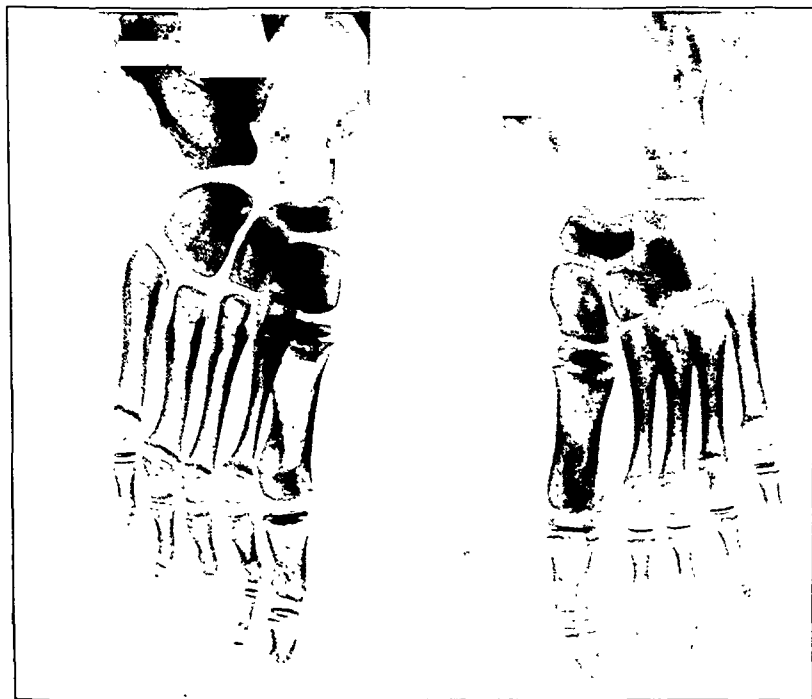


FIG. 5

Case 1. Anteroposterior and lateral views of the right foot twenty-six months after Fig. 3, showing the reduction in the longitudinal diameter of the internal cuneiform and the scaphoid, the irregular outline of the scaphoid, and the normal calcification of these bones.

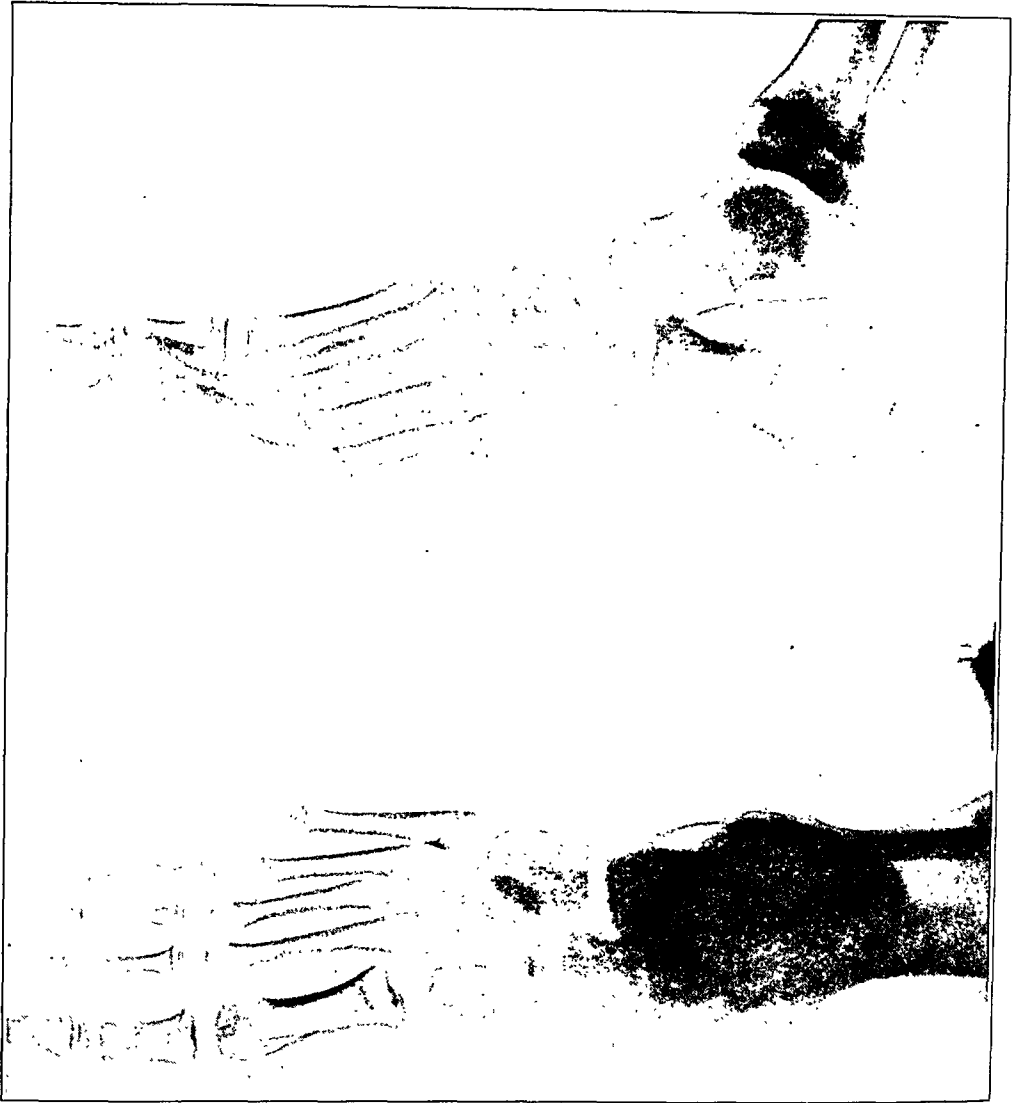


FIG. 7

Case 2. Anteroposterior and lateral views showing the lessened longitudinal diameter of the scaphoid and internal cuneiform with irregularities of outline and areas of condensation and rarefaction.

presents two ossific centers, and the bone may be divided by a suture into two, a dorsal and plantar.

The consensus of opinion is, therefore, that ossification begins at about three years of age. Immediately thereafter there is an unusually rapid growth to bring this ossific center to a size that is normally considerably larger than that of the second cuneiform which, according to the same authorities, begins to ossify at three or four years of age. There is, therefore, at this age a state of great developmental activity which brings with it a physiological weakness incidental to the rapid growth, thus making it a favorable site for the development of an osteochondritic disturbance.

The center of ossification for the scaphoid appears, according to Gray, and Bailey and Miller, at four years of age. Piersol and Spalteholz

place its time of appearance at four to five years of age, while Cohn notes it at three and one-half to four, and Haret, Dariaux and Quénu at two and one-half to three and one-half years of age. None of these authors makes mention of multiple centers of ossification, except Haret, Dariaux and Quénu who speak of a "*pointe interne*" at four to five and one-half years of age. It seems, therefore, justifiable to assume that the multiple areas of ossification noted in our case is not a normal variation. Furthermore, the subsequent appearance of both scaphoids, the areas of irregular ossification, their irregular outlines, and subnormal size all speak in favor of the belief that these bones were also subject to osteochondritic changes. A comparison of Figures 4 and 5 with Figure 6, which is a roentgenogram of a normal foot of a male child of the same age as that shown in the former figures, will make the above described changes very evident.

A detailed discussion of the etiology of this condition will not be entered into in this brief presentation, for this matter has already been discussed in detail in previous communications<sup>1, 2, 3, 4</sup>. Suffice it to say, however, that in all probability it is due to an imbalance of stress and strain imposed upon a physiologically weakened area. This imbalance may be due to an increased stress and strain, resulting from an abnormal weight or excessive activity, or it may be due to a diminished resistance incidental to rapid growth. The latter is probably the factor in these particular instances.

#### CONCLUSION

This communication deals with two cases presenting three instances of a hitherto undescribed and apparently rare focus of osteochondritic derangement of the internal cuneiform associated with a similar involvement of the tarsal scaphoid. The subsequent history of the first patient revealed a benign course and a reconstitution of the affected bones to a practically normal, though somewhat deformed and undersized state.

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## AN OPERATION FOR RECURRENT DISLOCATION OF THE SHOULDER

BY PERCY W. ROBERTS, M.D., NEW YORK, N. Y.

The fact that numerous operations have been proposed for surgical control of recurrent dislocation of the shoulder joint is evidence that all of them are lacking in some essential feature. It seems proper, therefore, to record a procedure which I have used twice during the past year which for simplicity and excellent functional results leaves little to be desired.

Before describing the operation, I wish to call attention to an observation made while undertaking studies on the cadaver which led to my adoption of the tendon-suspension principle of retaining the humeral head in its normal relation to the glenoid fossa. It is obvious that deflection of the tendon of the long head of the biceps across the head of the humerus to the upper margin of the glenoid was designed to assist in retaining the head of the humerus in contact with the scapula. To determine the importance of this arrangement, all of the structures spanning the shoulder joint were severed except the tendon of the long head of the biceps. It was found that if the tendon was then held firmly against the shaft of the humerus it was impossible to dislocate the humeral head until sufficient force was exerted to rupture the transverse ligament passing from the greater to the lesser tuberosity which holds the tendon in the bicipital groove. It was evident, therefore, that, in a normal individual, tension of the tendon produced by contraction of the long head of the biceps is one of the important factors in maintaining stability of the shoulder joint.

Nicola having demonstrated that conversion of the upper part of this tendon into a ligament does not perceptibly restrict motion of the shoulder, I proceeded in the following manner to insure stability of joints which had been habitually dislocating over a period of years:

Through an incision over the anterior aspect of the shoulder following approximately the direction of the fibers of the deltoid muscle, the capsule of the joint was exposed and opened by a T-shaped incision to reveal the long tendon of the biceps. The course of this structure was outlined on the underlying articular cartilage with a knife. The transverse ligament was divided and the tendon was lifted from its natural bed and retracted. With a gouge the bicipital groove was extended upward and inward across the humeral head, following the markings previously cut in the cartilage. This channel was made sufficiently deep to permit the tendon, when replaced in it, to sink below the level of the articular cartilage. The transverse ligament was sutured and a stitch carried through both tendon and ligament. The capsule was closed, the split deltoid allowed to fall into place, and the skin sutured. The arm was then put up in a Velpeau bandage until the wound was healed, when the arm was placed in a sling and restricted use was permitted.

CASE 1. Male, aged fifty-two years. Admitted to the Hospital for the Ruptured and Crippled on December 9, 1931, with a subcoracoid dislocation of the right shoulder which had existed for several months. Patient gave a history of recurrent dislocation of the joint at frequent intervals, following an accident three years previous to admission. X-ray showed diffuse osseous changes in the humeral head, the greater tuberosity, and the acromion process. On opening the joint, the head of the humerus was found tightly bound down under the coracoid process, making reduction extremely difficult. The capsule was so firmly adherent to the head of the humerus that it was necessary to resort to sharp dissection to release it. The transverse ligament was ruptured, and the tendon of the long head of the biceps was so frayed at the level of the tuberosities that its continuity was preserved by a few fibrous shreds. With a gouge the bicipital groove was extended upward and inward, the tendon was repaired and placed in the channel cut for it, and a suture was passed through the tendon and the remnants of the transverse ligament. To permit union of the tendon, the arm was kept in a splint for several weeks before active motion was permitted. Return of function was slow in this case, as was to be expected in a joint so badly damaged, but eventually full range of motion was restored and there has been no recurrence of the dislocation.

CASE 2. Male, aged twenty-three years, athletic type. Admitted to the Hospital for the Ruptured and Crippled on June 2, 1932. He had sustained a dislocation of the right shoulder five years previously. Since that time the dislocation of the shoulder occurred at frequent intervals, often without unusual strain. He was operated upon the day after admission by the method described above. On the eleventh day a sling was substituted for the Velpeau dressing and moderate use of the arm was permitted. In four weeks joint motion was possible throughout the normal range. From the fifth week on the patient indulged in increasingly strenuous gymnasium work, including boxing, wrestling, and overhead lifting of heavy weights. He also performed exercises on the parallel bars culminating in "hand stands" with the trunk and legs extended vertically upward supported by the arms. In addition to this, he has played tennis and professional football. He has experienced no sense of handicap in athletics, nor has he been conscious of the slightest instability of the joint, notwithstanding the severe use to which it has been subjected.

While the results of two cases operated upon within a year do not establish beyond question the value of this method of stabilizing shoulder joints subject to recurrent dislocation, there is reason to believe that it will prove an effective means of controlling these troublesome disabilities.

# A CASE OF COMPLETE DISLOCATION BETWEEN THE FIFTH AND SIXTH CERVICAL VERTEBRAE, WITHOUT FRACTURE

BY EDWARD N. REED, M.D., SANTA MONICA, CALIFORNIA

Complete dislocations between vertebrae, without fracture, are infrequent. In the cervical region they are usually fatal. The following case is of interest because of the complete dislocation without fracture, and because, in spite of severe cord damage, the patient not only survived but recovered a considerable amount of cord function.

Mrs. G. T., female, married, aged twenty-three years, on June 25, 1931, while playing on the beach, was lifted up and came down on the top of her head, with her neck flexed sharply forward. She was almost immediately paralyzed in all extremities. The paralysis was at first spastic but in a few hours it became flaccid.

Roentgenograms of her cervical spine showed an almost complete dislocation of the fifth cervical vertebra forward on the sixth. There was no evidence of fracture.

The neurological examination by Dr. Carl Rand showed a conscious and rational woman, suffering with considerable pain in the neck. Both lower extremities were completely paralyzed, with inability to move any muscle group. She was completely paralyzed in both forearms and hands. She was able to raise the arms at the shoulders, but could not lower them. She could flex both forearms but could not extend them. There was a complete loss of all forms of sensation ending abruptly at a level corresponding with the fifth and sixth cervical cord segments. The abdominal and epigastric reflexes were gone. The right biceps jerk was active, the left gone. Triceps, radial, and finger jerks were gone on each side. The knee jerks were quite active, the left being quicker than the right. The Achilles tendon jerks were active and equal. There was no Babinski on either side.

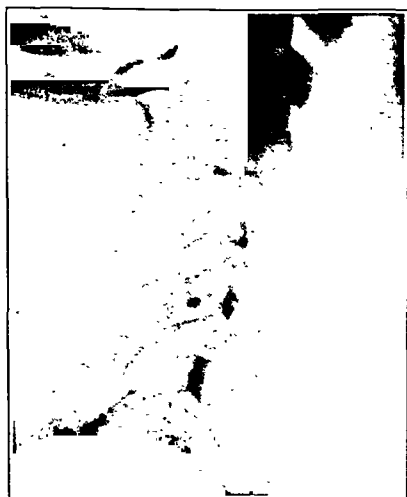


FIG. 1  
Before reduction

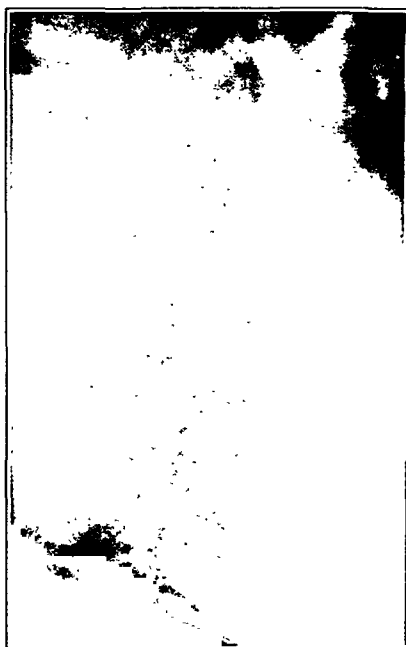


FIG. 2  
After reduction



Breathing was purely diaphragmatic. There was retention of urine.

On the following day all deep reflexes had disappeared.

Dr. John C. Wilson of Los Angeles reduced the dislocation on the day following the accident, by traction and manipulation, with the patient under anaesthesia. A head harness was put on, with two pounds of traction weight. Roentgenograms taken immediately after the manipulation showed a perfect reduction of the dislocation.

After six days the head traction was removed. The following day, on turning her head slightly, the patient felt something snap and immediately there was a return of severe pain in the neck. Roentgenographic examination showed a recurrence of the dislocation between the fifth and sixth cervical vertebrae. Dr. Wilson was away from the city at this time and the author was called upon to reduce the dislocation, which was again accomplished by traction and manipulation, and the reduction checked by x-ray. The head traction, with two pounds of weight, was kept on for four weeks, and on its removal a Thomas Collar was applied, which was worn for two months.

In spite of scrupulous care the patient developed an extensive ulcer over the sacrum. This was healed at the end of six months.

At the end of two months there were still increased reflexes in all four extremities, with ankle clonus and Babinski reflexes on both sides. But there was considerable motor return in the upper extremities and beginning of motion in the legs, with good tactile sensation and some pain and temperature sensation in all four extremities.

The patient ran a temperature throughout the first five weeks, over 105 degrees, axillary, on two occasions; at the beginning of the sixth week the temperature again became normal.

Control of bladder and rectum were lost and at time of last check-up, on April 4, 1932, had not been regained.

Examination on April 4, 1932, showed: Babinski reflex present on both sides, no ankle clonus, knee jerks exaggerated, from the suprapubic region downward tactile sensation but no pain or temperature sensation.

There is marked incoordination and muscular overaction in the lower extremities. Coordination in the upper extremities is fairly good. She can write a little. Sensation is good. She is beginning to walk in braces and with the aid of low parallel bars.

## DISLOCATION OF A SINGLE CUNEIFORM BONE

BY DWIGHT F. CLARK, M.D., AND H. A. QUINT, M.D., EVANSTON, ILLINOIS

*From the Surgical Department of the Evanston Hospital*

It is apparently necessary that an unusual dislocation, such as that of a single cuneiform bone of the foot, be produced by an unusual mechanical force. A review of the literature shows scarcely a half dozen references in which mention is made of a dislocation of the anterior tarsal bones of the foot. None refer to the displacement of a single cuneiform bone.

The following case is reported at this time inasmuch as more than a year has passed since the injury and it is possible to comment satisfactorily on the end results:

On October 26, 1931, Mrs. M. S., aged twenty-seven, was driving an automobile which, by the time it had skidded off the pavement, had succeeded in reducing its speed to a moderate rate when it collided with a tree. The patient stated that her right foot became doubled under the brake pedal at the time of impact; that she felt no particular pain at the time of injury; and that only a sense of numbness was experienced when she was removed to another automobile and taken home. Examination of the foot at that time showed no laceration of the skin but a considerable swelling of the dorsum of the right foot and inability to bear the weight on it. While roentgenograms at that time showed no injury to the right leg bones, there was found a dislocation of the middle cuneiform bone and also a fracture of the distal extremity of the third metatarsal bone of the right foot. Under nitrous oxid gas at the Evanston Hospital the same day, an effort was made to reduce the cuneiform dislocation and a plaster cast was applied with the foot in extension, on account of the apparent tendency to redislocation if the foot was allowed to return to dorsiflexion. Films taken the following day showed that reduction had not been satisfactorily accomplished. Two weeks later, after immobilization in different positions with such pressure applied as was borne well, only a slight improvement was noticed in the position of the cuneiform bone. It was therefore concluded that reduction and maintenance of this bone could not be accomplished in our hands and an open operation was decided upon for correction of the deformity. Dr. John L. Porter, who examined the patient, was in agreement with this decision. On November 16, 1931, or approximately seven weeks after the original injury, a curved longitudinal incision, two and one-half inches in length and centered over the cuneiform deformity, was made, having enough lateral convexity to escape the promontory of the dislocation. The exposure of the middle cuneiform bone, after retraction of soft parts down to the periosteum, showed that the bone was not capable of being replaced in its former position without completely freeing it from its surrounding attachments and performing what would appear to have been a mutilating procedure with risk of jeopardizing future function. The alternative of an osteotomy confined to the middle cuneiform bone was therefore performed. A gouge chisel was driven across the elevated portion so that that part of the bone was not only removed flush with the dorsal curve of the tarsus but enough was removed so that a slight concavity remained. The fascia and soft parts were stitched over with considerable care so that a smooth surface for the superimposed tendons might exist. The accompanying illustrations show the original dislocation of the cuneiform bone, the fracture of the distal extremity of the third metatarsal, the failure of various attempts at reduction and maintenance, and the final satisfactory result of the osteotomy together with the development of callus in the fractured metatarsal. The patient has been able to dance and use the foot without pain. Examination at this date shows no apparent difference in

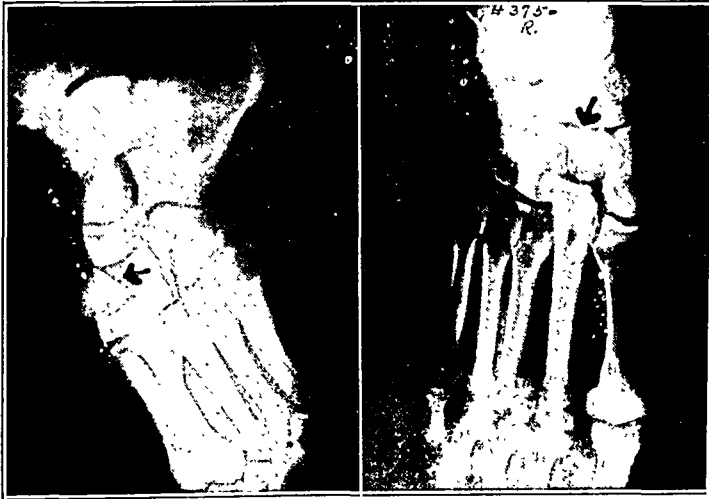


FIG. 1  
Roentgenograms taken immediately after injury October 26, 1931.

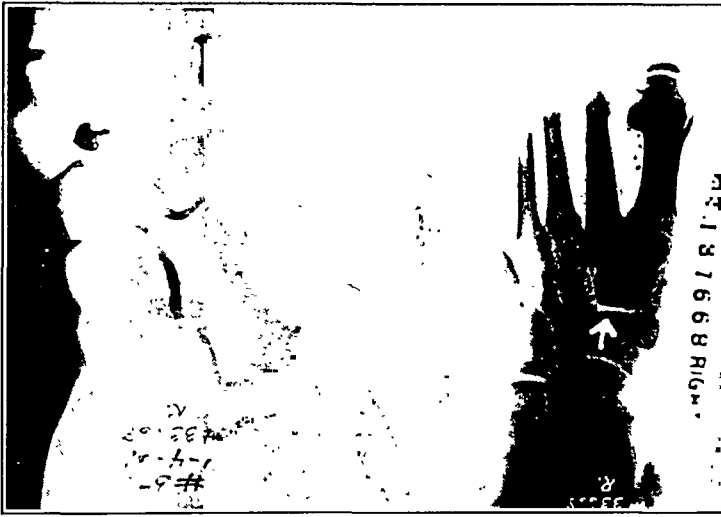


FIG. 2  
Roentgenograms taken ten days later, after unsuccessful attempts at reduction.



FIG. 3  
Roentgenograms taken five weeks following injury, after osteotomy of cuneiform bone.

the appearance or contour of the two feet, although the patient still experiences some slight pain in bad weather or after overuse. It is now possible for her to be fitted with mated shoes. It has come to be our conclusion that what disability existed may now be attributed more to the irritation at the site of the fracture at the distal extremity of the third metatarsal bone than to the cuneiform dislocation and subsequent osteotomy.

This case is brought to your attention partly on account of its rarity and partly because of the probability that such cases occur more often than may be supposed. It is fair to assume that an appreciable number of foot injuries, diagnosed as sprains, may really include a tarsal cuneiform dislocation. It is also probable that improperly taken x-rays, especially those taken in the lateral position with a certain degree of rotation, may fail to bring out such an anomaly even when well interpreted. Furthermore, there may be no doubt but that inexperience in interpretation in either good or bad films is responsible for the neglect of recognition and proper treatment of this important and disabling injury. It is our conviction that, like carpal dislocations, the laying down of fibrous tissue in the bed of the misplaced bone soon makes reduction mechanically impossible and it may not be successfully accomplished even when attempted very early. Inasmuch as the very few instances of record show both in treated and untreated cases rather uniformly poor functional and anatomical results, it stands to reason that if we would preserve the spring in the patient's step, avoid permanent injury to the arch, and prevent a permanently thick and painful foot that can be fitted to shoes only with difficulty, this supposedly unusual injury should be added to those we must consider in the differential diagnosis of injuries to the forefoot.

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# CARPOMETACARPAL ARTHROPLASTY OF THE THUMB

BY ROBERT PATTERSON, M.D., KNOXVILLE, TENNESSEE

Ankylosis of the thumb with the digit lying in the same plane as the hand renders the member practically useless. This is especially true if the fingers are stiff in complete extension, and the hand is swollen and indurated from passive congestion and disuse.

The problem presented in these cases is four-fold:

1. To overcome the flat hand deformity;
2. To flex the fingers and restore motion, especially apposition to the thumb;
3. To overcome brawny swelling and promote normal circulation;
4. To mobilize the thumb and develop its power of apposition to the fingers.

The first three indications are met by procedures well known to orthopaedic surgeons, but in dealing with an ankylosed thumb I was astonished to find only one reference to an arthroplasty of the carpometacarpal joint. MacAusland<sup>1</sup> states that this case was successful, and that the patient used the thumb in ten days.

## CASE REPORT

While driving an automobile in December 1931, Mr. V. L. was "side-swiped" by another car, while his left arm was projecting from the window. He received a compound comminuted fracture of the left elbow, and a Bennett's fracture of the left thumb.

Upon examination April 1, 1932, I found he had a painless range of motion in the elbow, from 90 degrees to 135 degrees, with some rotation. The thumb was ankylosed at forty-five degrees' abduction. The axis of the thumb coincided with that of the hand.

There was a slight "give" at the carpometacarpal joint, the ankylosis being fibrous. The hand was greatly increased in size, flat and indurated, with the fingers stiff in complete extension. The roentgenogram showed about one-third of the inner portion of the base detached, and lying between the first and second metacarpals, preventing adduction. It was decided to restore the use of the hand, as the first step in the restoration of the function of the arm.

## TECHNIQUE OF OPERATION

On March 30 an operation was performed as follows:

A straight incision was made, extending from the dorsal surface of the interphalangeal joint of the thumb proximally, and passing over the "anatomical snuff box" between the extensor tendons. The incision was carried to the bone between these tendons which were retracted to different sides. The carpometacarpal joint was opened. Dense adhesions were encountered as the joint surfaces were exposed, by completely severing these and the capsule beneath. The displaced portion of the head was removed with considerable difficulty. In doing so the radial artery was torn. The profuse hemorrhage that ensued was controlled by a tourniquet, and the operation was completed. It was found later that simple pressure with dressings and elevation controlled the bleeding.

The base of the metacarpal was freed entirely from the surrounding soft tissues and



FIG. 1



FIG. 2

Showing range of voluntary motion in thumb and fingers, July 18, 1932.

brought out of the wound. The cartilage was practically gone. Sufficient of the bone was removed to permit free motion, and the surface was rendered smooth with a file. No attempt was made to reproduce the exact shape of the normal joint surface; it was simply rounded off. A strip of fascia lata of sufficient size was removed and wrapped around the head, and held in place with purse-string suture. The inner glistening surface of the fascia was placed externally or next to the joint. The greater multangular joint surface showed evidence of disuse, but was little damaged. The wound was closed and a cast was applied with the thumb abducted and drawn medialward over the palm.

Active motion was begun the twelfth day. Measures were instituted to restore form and function to the rest of the hand at the same time and continued daily. There was surprisingly little pain and soreness in the new joint after two weeks.

Efforts to flex the fingers were continued until the end of May, but were fruitless on account of the contracture of the thickened capsules. Open posterior capsulotomies were accordingly performed May 30, 1932, by the subperiosteal elevation method of Silver. Flexion was then easily secured and maintained to a large extent. Physiotherapy was continued for several weeks.

#### RESULTS

The range of motion of the thumb is normal and power to grasp all but very small objects has been restored, as is shown by the illustrations. Patient was able to return to work as a truck driver, September 1932.

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# OLD DISLOCATION OF THE SHOULDER

## A NEW INSTRUMENT FOR REDUCTION \* †

BY WILLIAM ARTHUR CLARK, A.M., M.D., F.A.C.S., PASADENA, CALIFORNIA

On attempting to reduce an old dislocation of the shoulder by traction there is no stable point for countertraction. The heavy pectorals and the other muscles inserted near the head of the humerus transmit the pull to the whole shoulder girdle, which is thereby displaced in the same direction as the humerus when traction is made on the arm. Even in attempting open reduction, a fulcrum for leverage is not available. In attempting these open reductions it is seen that some method for getting countertraction directly on the scapula is needed.

The simple instrument described below will exert adequate traction

on the head of the humerus and at the same time hold back the glenoid.

The instrument is made of heavy strap iron two and two-tenths centimeters wide. The main arm is thirty centimeters long and a handle sixteen centimeters long is

formed by bending the iron at a right angle. The right-angle bend is reenforced with a wedge of iron soldered in the corner. In the handle part is a hole two centimeters from the main arm, through which is passed, fitting loosely, an ordinary bolt about fifteen centimeters long, with wing nut. The head end of the bolt is reshaped into a hook. The main arm ends in a shallow fork made to straddle the coracoid process. At the end, on the same side as the handle, is a spur made to impinge against the margin of the glenoid.

Having exposed the head of the humerus through an anterior deltoid incision, a wire is passed through it, just far enough down from the spongy bone to get a firm attachment. If there has been a fracture of the greater tuberosity or any other part of the head, the resulting callus, as well as the original fragment, must be removed. The remains of the joint capsule is opened up and retracted so that the glenoid cartilage is visible. Muscles and fascia must be cut from the distal third of the clavicle and

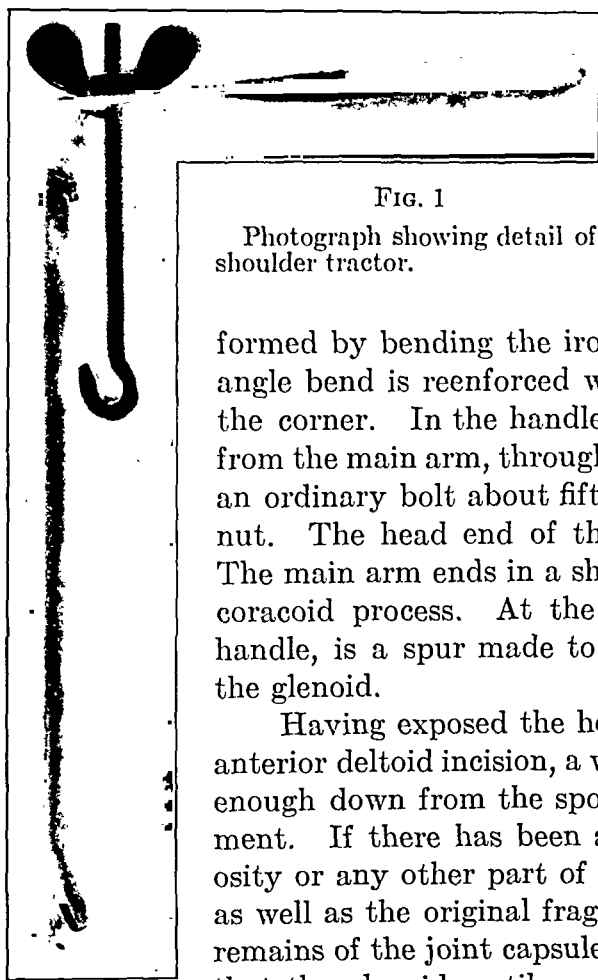


FIG. 1

Photograph showing detail of shoulder tractor.

FIG. 1

\* From the Orthopaedic Department, Los Angeles County Hospital. Service of Dr. T. M. Hart.

† Presented at the Annual Meeting of the American Orthopaedic Association, Toronto, June 18, 1932.

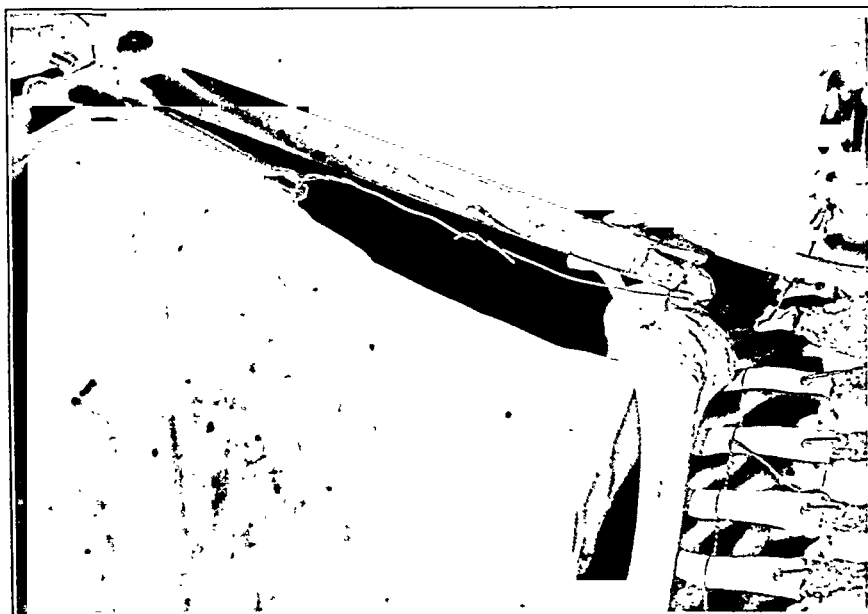


FIG. 2

Tractor applied with end on the coracoid.

reflected forward to get a good exposure of the coracoid process as well as of the dislocated head. It has been found necessary to sacrifice practically all of the muscle attachments around the head so that it is completely free to be pulled out.



FIG. 3

Tractor applied with end on edge of glenoid.





FIG. 4

Subcoracoid dislocation with fracture and separation of greater tuberosity. (Callus mass outlined by mark.)

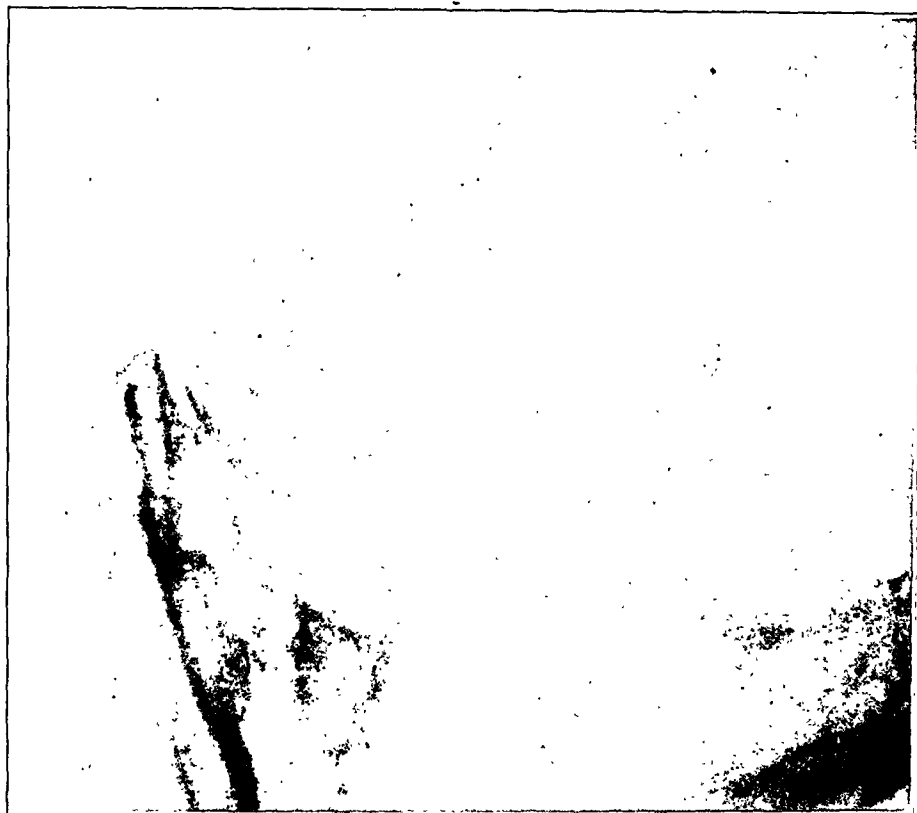


FIG. 5

Same case as in Fig. 3, after removal of callus and reduction.

The forked end of the extension tractor is then set firmly against the base of the coracoid process and the wire placed over the hook. Gradual traction is then obtained by means of the winged nut. When the head is well out from under the coracoid and at the level of the glenoid fossa, the traction is released and the tractor changed from the coracoid to the posterior margin of the glenoid, the spur at the end of the tractor being made to impinge against this margin. Traction is again applied. By manoeuvring the tractor, the proper direction of pull can be obtained to bring the head of the humerus into the glenoid fossa. The long head of the biceps tendon should be kept anterior to the head of the humerus.

I have used this tractor successfully on four cases. The first was a woman with a subcoracoid dislocation and fracture of the greater tuberosity which had remained unreduced for seven weeks. Attempt at closed reduction under gas failed, even after the arm had been in continuous skeletal traction for ten days. The result of open reduction with the aid of the tractor is shown in Figure 2. Three months later the head was still in normal position and function good.

The second case was of a very muscular man of fifty-seven with a subcoracoid dislocation of two months' standing. This was a very difficult case, but the head was finally manoeuvred into the glenoid fossa. Two months later the patient reported that the shoulder was still in place and, although motion was not normal, he was using the arm and noticed gradual improvement.

Case 3 was that of a Mexican sixty-two years of age. A subcoracoid dislocation had persisted for three months. It was reduced April 1, 1932. The long head of the biceps was accidentally ruptured near the glenoid and had to be sutured after the reduction. Motion was started in two weeks. Later information could not be obtained at this writing.

Case 4 (with Dr. Hart) was the most difficult of all, although the subcoracoid dislocation had been present only five weeks. The patient was a man of about fifty-five. The difficulty was due to our attempt to reduce it without sacrificing the muscle attachments around the head. It was thought that this might be done in view of the comparatively short duration of the lesion. However, after breaking the tip of the coracoid by counterpressure, the muscles had to be sectioned at the head. Counterpressure was then transferred to the posterior margin of the glenoid and reduction accomplished.

The instrument has been used successfully by three other surgeons in one case each, one being a dislocation of six months' duration.

# IMPROVED APPARATUS FOR RUSSELL TRACTION

BY D. O. CHAMBERLAIN, M.D., BROOKLYN, NEW YORK

*Kings County Hospital*

In 1924, R. Hamilton Russell of Melbourne, Australia, described a system of treatment of fracture of the femur which has been employed frequently at Kings County Hospital. The setting up of the necessary apparatus entails considerable work, a fact appreciated by the writer who was confronted with five such requirements in his first six days on the Fracture Service, so that a short cut was precipitated.

The apparatus, as shown in Figure 2, consists of a three-quarter inch, curved, galvanized iron pipe, thirty inches long with straight ends which permit telescoping of twelve inches, the intermediary six inches being curved to make an angle of 150 degrees. A bed hook which was designed by L. W. Roessler, a bracemaker of the Mayo Clinic, and described by Hugh T. Jones, is attached on the concave surface twelve inches from the lower end. Both ends have a collar through which a set-screw is sunk and from which protrude snugly fitting iron bars twelve inches long, bearing one pulley for the upper end and two for the lower.

The apparatus was constructed primarily for beds with a high horizontal bar, though with slight modification it could easily be made to fit any bed. Turned concave side upward, the lower pole is introduced from the foot of the bed through the space between the vertical bars which will be closest to the injured member, until the arms of the hook come in contact with the neighboring vertical bars of the bed. The apparatus is then rotated about the cross bar as its axis describing an arc

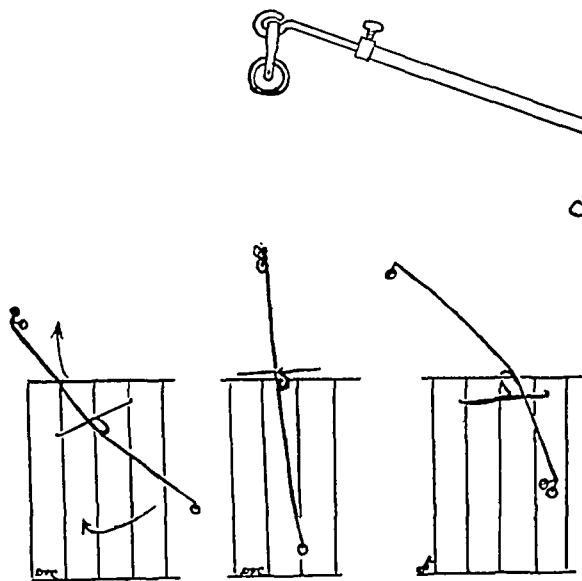


FIG. 1

Stages in application of apparatus to foot of bed.

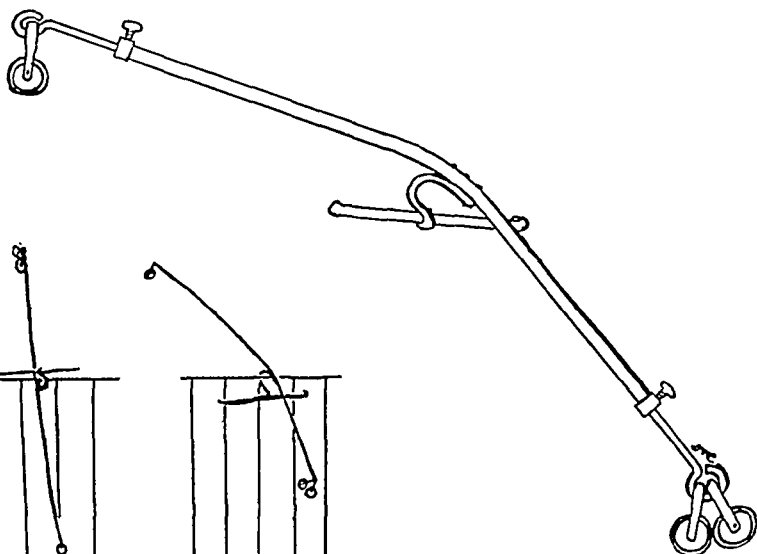


FIG. 2

The apparatus.



FIG. 3

The apparatus in use.

of 180 degrees (end for end). The concavity is now downward, the long pole directed upward over the leg, the short pole downward toward the floor.

The telescoping pulleys are then adjusted in the position described by Russell. The six-inch inequality in length of poles is balanced when weights are applied for the traction.

Aside from the ease of application, interference with the x-ray tube is avoided and there are no parts to get lost.

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## MODIFICATION AND EXTENDED USES OF BRADFORD FRAME

BY GEORGE M. LOGAN, M.D., AKRON, OHIO

Since the Bradford frame, or some modification of it, is so frequently used in maintaining patients, suffering from various conditions, in the recumbent position, its use could be extended greatly and certain other types of patients be handled with greater ease, safety, and comfort, if it were but made more comfortable to the patient.

The original Bradford frame, even with a supporting strip beneath buttocks, is not comfortable to patients because of parts sinking through the wide, rectangular-shaped aperture when the supporting strip is in position and particularly so when it is removed to permit use of the bed-pan. In the latter case it often permits more movement of the parts than is desirable from the standpoint of attempting to maintain immobilization, and also permits a resultant position certainly not desirable from the standpoint of comfort of the patient.

These objections to the original Bradford frame can be overcome largely by modification in the construction of the canvas support; and with a moderate amount of care in placing the patient on the canvas, the modified Bradford frame serves all the purposes of the original. The essential modifications are the changing of the rectangular-shaped aperture in the original to a diamond-shaped one in the modification and supporting the margins of the diamond-shaped aperture by strips of the same material along margins of the aperture, extending to the outer margins of the canvas, for reenforcement and to prevent sagging at the point where the maximum weight is sustained.

The essential features of construction and uses of this modification are:

1. Heavy, firm material—twelve-ounce white duck.
2. Supporting strips, of same material eight inches in width, securely sewed to the under side of the main canvas in diagonal direction, one margin of which reenforces the diamond-shaped aperture through the main body of the canvas. Margins of aperture of main top duck to be bound over margin of supporting strips.
3. Care should be exercised in construction of main canvas not to cut too much material in forming aperture that the margin may be securely bound and finished.
4. A three-inch hem around four outer margins of main body of canvas securely sewed.
5. Metal grommets inserted securely along center of hem at intervals of three inches.
6. Aperture slightly closer to one end of main canvas than the other—canvas shown in Figure 1—designed as thirty-three inches is to

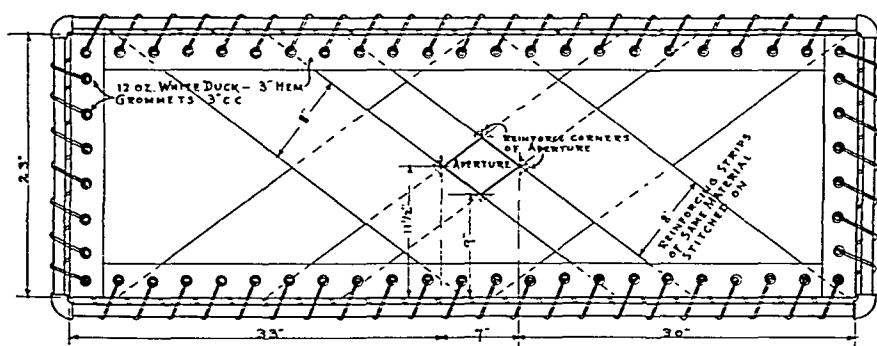


FIG. 1

Modification of the Bradford frame by the author.

thirty inches to provide for patients of different proportions. For patient having long legs and short body the short end should be toward the head, etc.

7. The sewing at angles of aperture should be reinforced by heavy linen thread.

8. The modified Bradford frame should be attached to a frame of gas-pipe of proper size,—two inches wider and two inches longer than measurement of main canvas and made of one-quarter inch to five-eighths inch gas-pipe, the same as the original Bradford frame. The smaller sizes are used for children.

9. The modified Bradford frame may be attached to bed by doubly curved straps of iron as in original Bradford frame.

10. Canvas tightly laced to gas-pipe as in original Bradford frame by window-sash rope or bell cord.

11. Top of Bradford frame when in use should be dressed separately in halves by at least four thicknesses of blanket and two thicknesses of sheet under body and leg portions and by combination abdominal pads made of cotton folded in gauze under buttocks at sides of aperture.

12. In case the Bradford frame is used for a patient with incontinence of urine, a rubber sheet thirty inches by twenty-three inches may be used with an opening in the center made by cutting, as in a crucial incision, slightly less in extent than the width or length of the aperture, so that the points of the rubber dam thus formed will hang down through the aperture and conduct the escaping urine into a bedpan beneath the frame without soiling the canvas.

13. The modified Bradford frame may be used to advantage in all cases endangered by unnecessary moving and lifting on bedpans,—such as injured and fractured spines and pelves and thighs, with or without plaster-of-Paris casts or other supporting apparatus; and in cases with incontinence of excreta and in all other subjects too dangerous, painful, or burdensome to be lifted upon a bedpan.

14. Dimensions of modified Bradford frame may be varied easily, either wider or narrower or longer, to suit patients of extraordinary sizes.

15. The Whitman modification of the Bradford frame, in which the longitudinal arms of the rectangular gas-pipe frame are curved, thus permitting the hyperextension of the spine in any desired segment as may be indicated, may be added.

16. A Balkan frame may be erected over the modified Bradford frame as over the original.

17. Where traction in longitudinal direction is required, the patient is easily maintained in the proper position on the frame by elevating the foot of the bed sufficiently to enable gravitation of patient to balance traction toward head of bed.



NATHANIEL ALLISON

### NATHANIEL ALLISON

May 22, 1876–August 30, 1932

The medical profession of America has lost a noted surgeon; the American Orthopaedic Association an eminent member, wise in its counsels, a friend of many and the companion of a few.

Nathaniel Allison, born in Webster, Missouri, May 22, 1876, was the son of James Allison, pioneer merchant, and grandson of Dr. Nathaniel Allison, pioneer physician of Audrain County, Missouri. The family tree sprang from early English, Colonial, and Revolutionary soil. Schoolboy days were spent in St. Louis at Smith Academy, and at seventeen he was admitted to West Point. At the end of a year the medical life of his greatly beloved grandfather made a stronger appeal than the military career which West Point offered. Further preparation at the Penn Charter School in Philadelphia enabled him to enter Harvard College in 1894. He transferred to the Medical School in 1897, and received his M.D. in 1901. After a training in Orthopaedic Surgery at the Boston Children's Hospital, he settled in St. Louis and was extraordinarily successful in combining laboratory research with clinical work, gaining the respect which his ability and industry deserved.



In 1909, he married Marion Aldrich of Chicago.

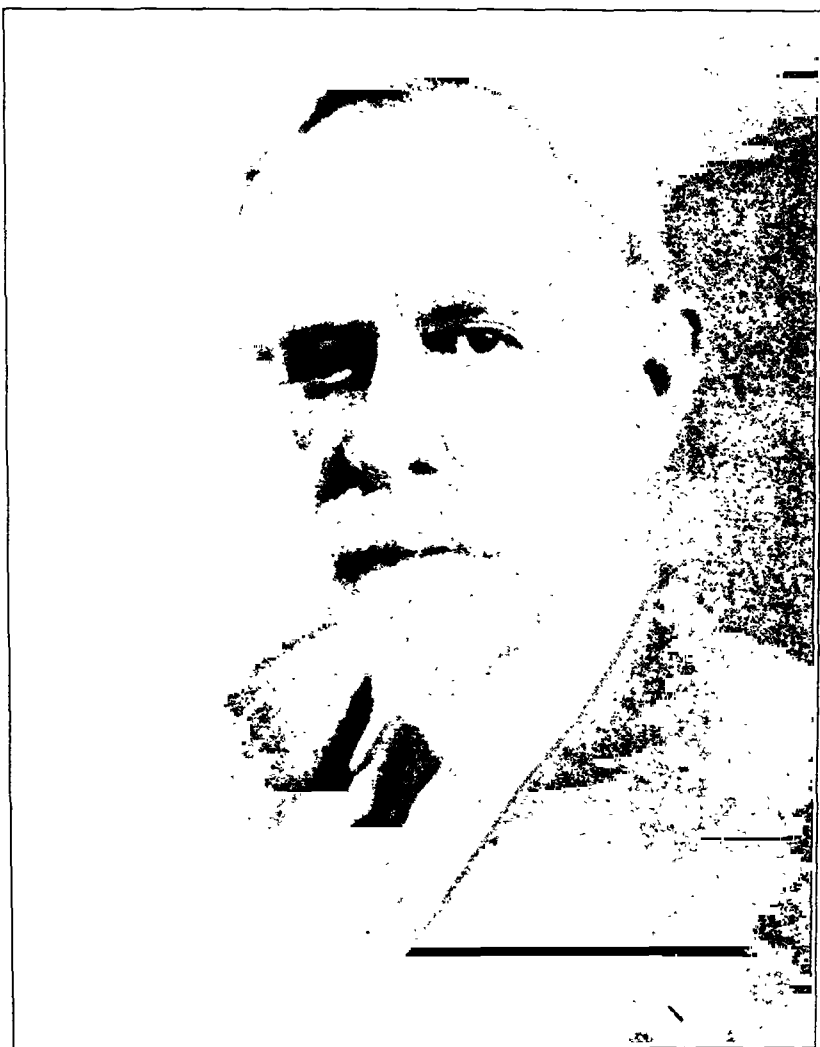
Few Americans had a more interesting or useful war service than Dr. Allison. He was commissioned as Captain and discharged as a full Colonel. Even before the United States entered the War, he had served with the American Ambulance in Paris. Later he was a member of the Army Board which standardized the splints and dressings of the American Expeditionary Forces. On his shoulders rested the chief responsibility for an adequate supply of these necessities. The problems of French manufacture, of American transportation, and of proper training of officers and stretcher-bearers in the application of these splints were knotty problems which he untangled with great skill and patience. On his return to America in 1919, he was assigned to the Walter Reed Hospital as Assistant Director of the Surgical Service and, in September 1919, after his discharge, was sent to Rome as representative of the Medical Department of the Army at the Inter-allied Congress of Surgery. The President of The United States awarded him the Distinguished Service Medal.

On his return to St. Louis, Dr. Allison was made Dean of the Medical Department of Washington University, continuing with his other duties as head of the orthopaedic teaching and hospital staff of the Medical School. In 1923, his medical Alma Mater called him to Boston and he became Professor of Orthopaedic Surgery in the Harvard Medical School and Chief of the Orthopaedic Department of the Massachusetts General Hospital. In 1929, he was invited by the University of Chicago to become a Professor of Surgery in charge of the Division of Orthopaedic Surgery and this invitation he accepted. These heavy responsibilities he continued to discharge until illness made it necessary for him to lay them down in 1932.

Dr. Allison's orthopaedic bibliography is voluminous. His monographs deal with almost every phase of the specialty in war and in peace. Clinical leads were followed into laboratory research, chiefly in association with Dr. Barney Brooks, then his St. Louis colleague. Their significant articles on "The Mobilization of Ankylosed Joints", on "Arthroplasty: Experimental and Clinical Methods", and on "Bone Atrophy: an Experimental Study of the Changes in Bone which Result from Non-Use" were published in 1915, 1918, and 1921, and represent important contributions to the knowledge of essential bone reactions. In addition to his contributions to current medical literature, he edited the orthopaedic sections of several Systems of Surgery. In 1929, with Dr. Frank R. Ober as American coeditor, and Sir Robert Jones and Mr. Harry Platt, F.R.C.S., as British coeditors, he prepared the revised second edition of Jones and Lovett's "Text-book of Orthopedic Surgery". In 1931, in collaboration with Dr. Ralph K. Ghormley, he published "Diagnosis in Joint Disease: A Clinical and Pathological Study of Arthritis"; and in 1932, in collaboration with Dr. Robert B. Osgood, "The Fundamentals of Orthopaedic Surgery in General Medicine and Surgery".

If "a man is known by the company he keeps", Dr. Allison was well known as a partial list of the medical and civic societies to which he belonged abundantly attests: fellow of the American College of Surgeons, of the New England Surgical Society, and of the American Academy of Arts and Sciences; honorary member of the British Orthopaedic Association; corresponding member of the Société des Chirurgiens de Paris; member of the American Orthopaedic Association (President, 1922), the International Society of Orthopaedic Surgery, the American Medical Association, Southern Surgical Association, Association of Military Surgeons, Massachusetts Association for Occupational Therapy (President, 1925-1929), the St. Louis Surgical Society, Boston Orthopaedic Club, and many urban and country clubs in St. Louis, Boston, Chicago, and Washington.

Wherever this genial but self-contained and unhurried physician practised, he became a vital element in the professional life of the community and the trusted adviser of important medical institutions. He was independent in thought and action and by the exercise of his own wisdom and effort usually attained the end sought. He broadened the scope of Orthopaedic Surgery by research; and increased its prestige by the respect in which he was held by medical and surgical colleagues, a respect engendered by his knowledge of men and of medicine.



RUSSELL A. HIBBS

### RUSSELL A. HIBBS

Dr. Russell A. Hibbs, Surgeon-in-Chief of the New York Orthopaedic Dispensary and Hospital and Professor of Orthopaedic Surgery in the College of Physicians and Surgeons, Columbia University, died in New York on September 16, 1932. His death is an incalculable loss to Orthopaedic Surgery. Early in his career he began the long list of notable contributions which continued to the end.

In 1902 he wrote a prize essay on the treatment of fractures of the femur. In the same year he pointed out the harmful results which often followed subcutaneous tenotomy of the tendo achillis, and in 1906 published a new method of lengthening the Achilles and other tendons. "An Original Method of Operating on Congenital Dislocation of the Hip" appeared in 1908.

"An Operation for Stiffening the Knee Joint" was published in 1911. Perhaps his greatest achievement, the spine fusion operation, was described in a paper called "An

Operation for Progressive Spinal Deformities," appearing in the same year. Although this was first used in the treatment of Pott's disease, the title shows that Dr. Hibbs foresaw the possibilities of the procedure in other conditions, a vision which soon was fulfilled in its application to scoliosis, fractures, abnormalities of the lumbosacral region, etc. It is not exaggerating to say that the operation has revolutionized the treatment of those conditions.

A paper on "Muscle-Bound Feet", including the application of the new method of lengthening the tendo achillis to this condition, was printed in 1914 and was followed by one on "An Operation for Claw-Foot" in 1917. The first résumé of the results of spine fusion in the treatment of lateral curvature was given in 1923 in "A Report of Fifty-Nine Cases of Scoliosis Treated by the Fusion Operation." The last great triumph came in the perfecting of a method for fusing the hip. This was published in 1926. Any one of these papers would have secured for him a lasting place in the roll of those who have done great things for Surgery. That this whole list should have come from the hand of one man is truly remarkable.

Dr. Hibbs's name probably will be identified most conspicuously with treatment of joint tuberculosis. He was at first almost alone in believing that it could be cured only by fusing the joint, and his steadfast adherence to this principle in the face of widespread opposition, together with his skill in developing methods for carrying it into effect, have made him, more than any other, responsible for its general acceptance today. Surely it is not too much to say that he was among the very foremost in placing Orthopaedic Surgery on a modern footing and making it a real part of Surgery.

Only his associates know the many other sides of this remarkable character. He was a genius in organization and administration. When he was appointed Surgeon-in-Chief of the New York Orthopaedic Dispensary and Hospital at the age of thirty, it was a small institution occupying a converted dwelling house. His great ability and enthusiasm won the support which made possible the development of the hospital to its present greatness. In 1903 he founded the New Jersey Orthopaedic Hospital and was afterward responsible for its conduct on the same lines as his own hospital.

His interest in medical education and his insistence upon the need for better post-graduate training for surgeons led to the establishment of the Annie C. Kane Fellowships at the Orthopaedic Hospital. His lectures at the College of Physicians and Surgeons aroused the keen interest of all the students and made his course one of the most popular in the curriculum. His personality left its stamp on every young man who went through his hospital as a house officer. He loved nothing better than to meet and talk with the alumni and his interest and warm sympathy were a source of lasting inspiration to them all.

Dr. Hibbs was born at Birdsville, Kentucky, on September 1, 1869. He attended Vanderbilt University and was graduated from the Medical College of the University of Louisville in 1890. After practising for several years in Texas he went to New York and in 1894 became Resident Surgeon at the New York Orthopaedic Dispensary and Hospital. Six years later, in 1899, he was made Surgeon-in-Chief. He was appointed Professor of Orthopaedic Surgery at the College of Physicians and Surgeons, Columbia University, in 1918. He was president of Hope Farm, a community home for children, a member of the American Orthopaedic Association, the Interurban Orthopaedic Club, the Practitioners' Club, the Union Club, a fellow of the American Medical Association, the American College of Surgeons, and the New York Academy of Medicine. He was consulting surgeon of the Presbyterian, French, Babies', Sea View, and Beekman Street Hospitals, the New York Infirmary for Women and Children, and St. John's Riverside Hospital, Yonkers, New York.

On September 1, 1904, Dr. Hibbs married Miss Madeline Cutting, daughter of the late Walter Cutting, at Pittsfield, Massachusetts. She survives him, as well as a brother and two sisters.

# News Notes

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\* Dr. Edward S. Hatch announces that Dr. Dudley M. Stewart is now associated with him in practice. Their office is located at 3505 Prytania Street, New Orleans, Louisiana.

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By invitation of the Board of Trustees of the Bishop Clarkson Memorial Hospital, friends of the Hospital gathered on Sunday afternoon, December 4, for the unveiling and presentation of a portrait of Dr. John Prentiss Lord. The portrait was a gift to the Hospital from the Staff in recognition of Dr. Lord's long and faithful service to the Institution.

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**The Annual Meeting of the Interurban Orthopedic Club** was held in Buffalo on October 28 and 29. An unusually interesting program was offered by the Committee and by the orthopaedic staffs of the Buffalo hospitals. Cases were presented at the Buffalo General Hospital, The State Institute for the Study of Malignant Disease, and the Children's Hospital, and rather remarkable results of treatment of various cases were shown in these demonstrations.

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At the Meeting of the **Chicago Orthopaedic Club** on November 11, Dr. Ferdinand Seidler presented a paper on "The Shelf Operation in Stabilization of the Hip", and Dr. Leo F. Miller spoke on "Orthopaedics as Seen in the Clinics of Prof. Riccardo Galeazzi and Prof. Vittorio Putti". General discussion followed the presentation of these papers.

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*The Journal* has been informed of the recent death of Miss Jane A. Neil, formerly principal of the Spalding School for Crippled Children in Chicago. The Spalding School, of which Miss Neil became principal in 1914, was the first school of its kind in the country. In 1928, Miss Neil became district superintendent of special schools in Chicago and she instituted many new courses in the schools under her supervision. She maintained that "education of the crippled child is not philanthropy but enlightened self-interest".

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At the Meeting of the **British Orthopaedic Association**, held in London, July 27, 1932, the following officers were elected to serve for the year 1933:

Emeritus President:	Sir Robert Jones, Bart., K.B.E.
President:	A. S. Blundell Bankart
Vice-President:	S. T. Irwin
Hon. Treasurer:	W. R. Bristow
Hon. Secretary:	E. P. Brockman
Editorial Secretary:	G. Perkins
Executive Committee:	{ P. Jenner Verrall
	{ S. A. S. Malkin
	{ S. L. Higgs
	{ W. A. Cochrane

At the **Réunion d'Orthopédie et de Chirurgie de l'Appareil Moteur de Bordeaux** on June 9, 1932, a large number of interesting papers were presented by the members and guests. The following list will demonstrate the wide scope of subjects considered and the interesting and important papers presented:

The Myeloplastic Tumor of the Upper Portion of the Fibula, with Partial Resection. By Dr. Charles Lasserre.

Subtrochanteric Osteotomy for Support in Pseudarthrosis of the Neck of the Femur. By Dr. André Treves.

The Problem of Hyperdactylia. By Dr. Max M. Klar.

Vertebral Epiphysitis in a Patient of Thirty-Eight Years. By Dr. René Gourdon.

Four Cases of Vertebral Epiphysitis in Adolescents. By Dr. Benoiste-Pilloire and Dr. René Gourdon.

Femoral Metaphysitis. By Dr. Benoiste-Pilloire and Dr. René Gourdon.

Multiple Congenital Malformations. By Dr. Benoiste-Pilloire and Dr. René Gourdon.

The Technique of Ankylosing the Upper Extremity of the Femur in Deforming Osteo-Arthritis of the Hip. By Dr. H. L. Rocher.

A Severe Fracture of the Calcaneum, with Immediate Reduction under Local Anaesthesia. By Dr. H. L. Rocher.

Bilateral Congenital Dislocation of the Radius. By Dr. Charles Lasserre and Dr. Saft.

Osteomyelitis of the Two Hips at Nine-Year Intervals. By Dr. Edouard Papin.

An Unusual Lesion of the Cervical Region. By Dr. Edouard Papin.

Complete Osteogenic Absence and Ankylosis at the End of Eight Months in Extra-Articular Arthrodesis Performed for an Old Congenital Dislocation of the Hip. By Dr. Charbonnel and Dr. Masse.

Old Luxation of the Elbow Treated by Osteotomy of the Olecranon. By Dr. Robert Guerin.

At the **14<sup>e</sup> Réunion Annuelle de la Société Française d'Orthopédie**, held in Paris on October 7, 1932, the special subjects considered were "The Surgical Treatment of Scoliosis" and "The Early Treatment of Acute Osteomyelitis".

Dr. Fèvre, of Paris, presented the subject of Surgical Treatment of Scoliosis. He took a moderate position in regard to the surgical treatment, reserving it for cases which have had prolonged conservative methods and those in which the conservative treatment is not particularly encouraging,—for instance, in paralytic scoliosis. He presented a new method of procedure, simple and rapid, which provides a large area for the graft.

The Early Treatment of Acute Osteomyelitis was presented by Dr. Ingelrans, of Lille. He gave a review of the different forms of treatment, including vaccination and the total and early excision of the diaphysis, as well as the simple periosteal incisions with or without trephining. In his conclusions he stated that, although early resection gives good immediate results if done under proper conditions, it is not always considered necessary, and up to the present there has been insufficient time to determine the complete end results.

At the **41<sup>e</sup> Congrès Français de Chirurgie**, held in Paris in October, 1932, Prof. Cunéo, of Paris, and Prof. Rocher, of Bordeaux, discussed "The Surgical Treatment of Chronic Non-Tuberculous Arthritis of the Hip Joint".

A most complete presentation of this subject was given, too thorough and too complete for abstract. In the first part were discussed the essential features,—such as, etiology, pathology, clinical symptoms, and therapeutic indications. The second portion of the presentation was devoted to a consideration of the surgical technique of the various procedures.

The XXIII Congresso della Società Italiana di Ortopedia was held at the Istituto Rizzoli in Bologna on October 15, 16, and 17, under the leadership of the President, Prof. Riccardo Galeazzi, and a most interesting program was presented.

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Professor Božidar Spišić, President of the Yugoslavian Orthopaedic Society, opened the Congress of the Yugoslavian Orthopaedic Society and the Czechoslovakian Orthopaedic Society at Zagreb on October 3 by his Presidential Address in which he considered especially the subject of the care of cripples and the position of orthopaedic surgery. Professor Spišić stated that, at the beginning of his work in Zagreb twenty-five years ago, orthopaedic surgery was unknown, but now its importance is being gradually recognized, as is seen by the organization of this new Society. He gave full credit to the men prominent in this specialty, both in Europe and in America, and acknowledged their influence in the development of orthopaedic surgery during the last two decades.

Along with this development there has also been the recognition of the need of the care of the cripple and his right to obtain such care. He stated that the cripple, although handicapped by his deformity, must still remain a part of the community and is, therefore, entitled to the opportunity for education and adequate training for self-support. He also called attention to the psychological effect of the cripple's physical infirmity and the need of reconstruction of his mental attitude, and pointed out that everyone in the community should contribute to this work. The cripple can and must be made a useful member of society, and to accomplish this it is necessary that some occupation be found for him of which he is capable. These goals were kept in mind in the founding of the Orthopaedic Hospital in Zagreb, and a large part of this Institution has been devoted to this special work.

The Society had a very successful meeting in which members from both Yugoslavia and Czechoslovakia took an active part.

# Current Literature

**THE DIAGNOSIS AND TREATMENT OF POSTURAL DEFECTS.** By Winthrop M. Phelps, B.S., M.D., M.A., F.A.C.S., and Robert J. H. Kiphuth. Springfield, Illinois, Charles C. Thomas, 1932. \$4.00.

In this rather unusual book the author has given the results of long study of this subject of posture, using an extensive series of examinations of young people of various ages, and has also considered the information which has been contributed by the several branches of medicine. Posture is presented as one of the considerations in the general problem of development and growth as influenced by environment and heredity.

In the first portion of the book the function of the structural variations are treated and many practical but often not sufficiently recognized conditions are demonstrated. The athlete is not necessarily perfect, and the normal posture must vary considerably with different ages. Various conditions connected with the development of posture and growth are clearly discussed and fully illustrated. Attention is called to the distinction which must be made between the pre-adolescent and the adolescent periods, and the author points out the influence of the instinctive play of children, as well as the more elaborate and organized exercises in the adolescent period, on the development of posture and posture defects. The percentage of physical defects in the pre-adolescent period is comparatively small and exercises are, therefore, at this time not so important.

Considerable stress is laid on and a chapter devoted to the subject of body mechanics, and the principal joint areas are analyzed with reference to their effect on the whole problem of posture. The defects of these areas are also given special consideration.

A large part of the work is devoted to the subject of posture examination and faulty posture, also to the effect of overdevelopment and overtraining which in general has not been given a place of sufficient importance in the treatises on this subject. In addition, the book contains rules for physical development and correction of posture faults and defects, as well as individual exercises, both developmental and corrective. A series of statistics of the classification and grouping of the different defects follows this portion.

By all students of posture, this book should be carefully studied.

**A SHORTER ORTHOPAEDIC SURGERY.** By R. Brooke, M.S., F.R.C.S. New York, William Wood and Company, 1932. \$3.00.

The author states that this book was written with a view to meeting the needs of instructors in the medical schools and of the undergraduate students. The schools do not attempt to graduate students as specialists, but rather to provide them with a sufficient knowledge to serve as a foundation for their further experience and study, and this book is designed to aid in this education.

The author has chosen a very convenient and successful method of presentation,—considering each joint separately with the special affections to which it is subject, rather than describing the diseases with their special manifestations in the various joints. This method gives to the reader a very clear idea of the behavior of the joints under different conditions. There is sufficient anatomical description to serve as a basis for the later discussion of each subject, and the different diseases are discussed in their etiological, pathological, and diagnostic aspects. The various procedures of treatment—both conservative and operative—are considered, but not in too much detail; the reader is given, rather, a bird's-eye view of the subject, including the possibilities of the effect of the disease and the results of treatment. In the chapter on the foot the subject is treated a little more in detail, but the average young practitioner is very likely to be called upon to treat the conditions described and should be better fitted to do so. Par-

ticularly clearly are given in an excellent table the directions for the choice and the application of proper shoes for the various types of feet.

The book is fully illustrated by excellent photographs and drawings and will meet the need for which it is intended.

**PRINCIPLES OF ORTHOPEDIC SURGERY FOR NURSES.** By James Warren Sever, M.D., Ed. 2. New York, The Macmillan Company, 1932. \$2.50.

As the title indicates, this work is primarily intended for the instruction of nurses. The avoidance of technical language, and the use of explanations when such language is used, makes the book of value for the student nurse. Careful attention given to the daily problems in orthopaedic nursing,—such as the nursing care of a child in a cast, the care of a patient with tuberculosis of the spine, bringing out the details of feeding and dressing problems, makes the work of special value to floor supervisors, graduate nurses, and others who have the care of orthopaedic patients.

Others than nurses will find the book helpful. Social service workers who must deal with the crippled will find their problems discussed. Medical stenographers, medical librarians, and the custodians of hospital record rooms may quickly gain knowledge of orthopaedic terms hereby, so that these terms mean more to them than peculiar collections of letters. Brace-makers will find described and illustrated the standard braces that are used over and over again in so many disabilities. The illustrations and descriptions should be helpful to those responsible for hospital paraphernalia.

Dr. Sever has developed this book through years of experience, and the fact that he has had to crystallize his own knowledge and make it easily understood has produced a book easily read and of value to physicians and orthopaedic specialists as well.

**MASSAGE AND THERAPEUTIC EXERCISE.** By Mary McMillan. Ed. 3. Philadelphia, W. B. Saunders Company, 1932. \$2.75.

In the third edition of this book, Miss McMillan has given a helpful guide to the student as well as to the practitioner of physiotherapy. She has recognized the constantly accumulating medical information which must be considered in dealing with those affections to which physiotherapy is applied, and has rewritten two chapters and added much to the text of the previous edition. To understand the basic principles of physiotherapy and their application is essential, and the first portion of the book which deals with this part of the subject should be studied. The various forms of massage are described in detail, and illustrated by photographs and drawings, and their practical application to the different parts of the body and to the joints is given consideration. An instructive chapter is devoted to the description of the different movements of the joints, which should always be taken into consideration in the application of massage and physiotherapy. The chapters on the foot and on scoliosis contain descriptions of many exercises, the value of which has evidently been proved by practical experience. The exercises are illustrated by excellent line drawings and their application to the different curves are indicated.

Throughout the book much has been added from the recent accumulation of knowledge and from the author's constantly increasing experience in this special therapy. Each chapter is well illustrated and the book is to be recommended for all who are particularly interested in massage and the different forms of physiotherapy.

**POLIOMYELITIS.** Baltimore, The Williams & Wilkins Company, 1932. \$6.00.

This work is the end result of a survey made possible by a grant from the International Committee for the Study of Infantile Paralysis, organized by Jeremiah Milbank. The book covers the entire available literature on the subject of poliomyelitis and has been carefully classified, so that all of the subject matter may be relied upon to maintain a high degree of accuracy.



A summary of the historical aspect of poliomyelitis is given, beginning with Heine's Monograph in 1840 and continuing to the present time.

The etiology of the disease is next considered with special reference to the earlier bacteriological theories. The nature of the virus and its distribution in the body is discussed at length. The experimental disease, especially in monkeys, and the various tests and peculiarities of the disease in monkeys is explained.

A careful survey of the literature on resistance and immunity is followed by a thorough and complete discussion of the symptomatology.

The chapter on treatment covers all of the accepted measures and is filled with much excellent statistical material on the results of the various types of treatment. This chapter deals entirely with the treatment of the acute stage except for a small section on a description of the respirator. The treatment after the end of the acute stage is very briefly outlined and covers about one page.

The pathology is given in great detail and there are, in this chapter, many plates showing the microscopic findings in the various parts of the cord and brain.

The final chapter, which is by far the longest chapter in the book, is a consideration of the epidemiology of the disease. This is very completely worked out and contains references to work as late as the fall of 1932. There are innumerable statistical tables and a thorough reading of this chapter will prove of great value to all interested in any phase of the disease.

A topical analysis of the book is appended, as well as a bibliography of 843 articles. There is a short addendum giving the results of the administration of normal adult serum in the prophylaxis of poliomyelitis during the 1932 epidemic in the City of Bradford, Pennsylvania.

The committee is to be highly complimented for the great work in bringing together all of this material. It would consume an indefinite amount of time and great labor for any individual to gather a knowledge of the acute stage of poliomyelitis such as can be gained from this book. It should be emphasized, however, that the work does not deal in any way with the orthopaedic phase of the disease. References are given to the standard text-books for this. The book is primarily for pediatricians and internists, but a knowledge of its contents should be acquired by all of those working with poliomyelitis.

**MENTAL DEFICIENCY DUE TO BIRTH INJURIES.** By Edgar A. Doll, Ph.D., Winthrop M. Phelps, M.D., and Ruth T. Melcher, M.A. New York, The Macmillan Company, 1932. \$4.50.

The title of this small volume (289 pages) covers but one aspect of the material contained. It really represents a careful group study of cerebral birth injuries (spastics) with a threefold purpose:

1. To describe birth injury as a clinical category of mental deficiency by enumerating its mental and physical characteristics.
2. To point out the features of the present psychological tests or observations, which are inadequate for subjects in whom both language and motor handicaps are present, and to suggest modifications which will give more satisfactory indications of their actual ability.
3. To observe, by the use of these methods, what mental development accompanies motor development resulting from physical therapy.

For those who regard cerebral birth-injured children with little less than scorn, or, at best, with an attitude of hasty surgical interest, a careful perusal of the sympathetic approach of these investigators, as set forth in the introduction, is recommended. The chapter on etiology is a concise survey of the contemporary literature and is fairly complete.

The mental tests and measurements used apparently show the Stanford Binet as the most workable for children of the class studied.

Dr. Phelps's chapter on physical therapy is of inestimable value and appears both

theoretically and practically sound. It deals with the fundamentals of the subject,—namely, a correct estimate of the types of dyskinesia with a careful differentiation between those due to pyramidal-tract involvement and those which are secondary to extra-pyramidal or basal nuclei lesions. He recognizes, of course, mixed types.

Treatment proceeds from relaxation to gross movements of the proximal joints, the finer coordinated patterns being the last to be established.

This book should be of interest to all workers in the fields of psychiatry, physical therapy, and orthopaedic surgery.

**PHYSICAL THERAPY IN INFANTILE PARALYSIS.** By Arthur T. Legg, M.D., and Janet B. Merrill. Reprinted from *Principles and Practice of Physical Therapy*. Hagerstown, Maryland, W. F. Prior Company, Inc., 1932.

In this little book the authors have put into a convenient form for presentation this special treatment of infantile paralysis. Both authors are particularly fitted to give to the medical public the recent information in regard to physical therapy and the best method of its application to this disease. With the increasing prevalence of infantile paralysis such a work has definite value. Many of the important facts with reference to this affection—its etiology, pathology, etc.—are presented in concise form. The disease is considered in four stages. The various forms of physiotherapy to be used are described, and their use for and application to the special body areas in the different stages are considered in detail with clear directions and many tables. It is a valuable work for the physiotherapist and for the physician who wishes to follow the details of treatment in these cases.

**DISEASES OF THE SPINAL CORD.** By Williams B. Cadwalader, M.D., Professor of Clinical Neurology, University of Pennsylvania Medical School. (With an introduction by William G. Spiller, M.D., Professor of Neurology, University of Pennsylvania Medical School.) Baltimore, The Williams & Wilkins Company, 1932. \$5.00.

The well known author of this text-book presents a compact treatise on diseases of the spinal cord.

He prefaces his discussion of the clinical features of disease with several chapters devoted to their elucidation on anatomical and physiological grounds. The first chapter deals briefly with the neuron theory, the second chapter with the grouping and relation of tracts and the blood supply of the cord, the third chapter with reflexes and reflex action, the fourth and fifth with the topographic diagnosis of disease, citing the symptoms resulting from implication of the various tracts, and stressing the rôle of the sympathetic nervous system in relation to pain. The remaining ten chapters consider in a concise and thorough manner the clinical features of cord disorders.

Many of the illustrations are drawn from original sources. The bibliography in itself is well chosen and worthy of reference by the reader. The book is altogether clear and informative.

**RADIOLOGIC MAXIMS.** By Harold Swanberg, B.Sc., M.D., F.A.C.P. Quincy, Illinois, Radiological Review Publishing Company, 1932. \$1.50.

It is always valuable to have the results of experience recorded in concise form, to serve as a guide to those whose experiences have been less or different and who have had less opportunity to formulate their information. In this book the author has gathered under appropriate groupings a very large number of suggestions for guidance in the uses of the x-ray and roentgen therapy, and has put them almost in the form of aphorisms. In addition to his own, he has collected the opinions of surgeons of prominence and experience.

Part I is devoted to the maxims with reference to radiology in general, Part II to

roentgen diagnosis, and Part III to radiation therapy. For all those who employ roentgen therapy this book will be found to contain a great many helpful suggestions and to serve as a reliable guide.

TRATAMENTO CIRURGICO DA TUBERCULOSE OSSEA (Surgical Treatment of Bone Tuberculosis). By Barros Lima, Professor of Orthopaedic Surgery, Faculty of Medicine of Recife, Brazil.

Barros Lima presents a complete review of the different procedures actually in vogue for the surgical treatment of bone tuberculosis. He divides his book into three chapters:

The first chapter is devoted to the surgical methods for the excision of the lesion itself, synovectomy, arthrectomy, intra-articular or extra-articular evacuation, epiphyseal evacuation, resection, and amputation. He makes a critical review of each of these methods, establishing its indication, and he presents clinical histories of his own cases.

The second chapter is devoted to the operations directed toward obtaining a modification of the tissues in which the tuberculous infection is acting, such as, sympathectomy, Robertson Lavalle's operation, Vignard's operation, Maragliano's operation.

The third chapter is undoubtedly the most important one. It is devoted to the surgical procedures leading to fusion of the tuberculous joints, in order to obtain the cure of the lesion by surgical immobilization of the part. The well known techniques of Albee and Hibbs for Pott's disease, and Berard's modification of the former, which the author prefers, and the various techniques for the fusion of tuberculous hip are discussed, and finally a description of the fusion procedures in other joints.

*The Journal* wishes to acknowledge the receipt of the following publications sent to the Editorial Department:

Twenty-Fifth Annual Report of the Hospital for Joint Diseases. New York, 1931.

Verzeichnis der Ärztekurse im Studienjahre 1932-1933. Kursorganisation der Wiener Medizinischen Fakultät. Vienna, Minerva Wissenschaftliche Buchhandlung Gesellschaft m.b.H., 1932.

Cyphose Dorsal Juvenil. By Dr. Aresky Amorim. Rio de Janeiro, Canton & Reile, 1932.

Acta Radiologica. The Axel Reyn Birthday Book. Stockholm, Sweden, Vol. XIII, Fasc. 3 and 4, 1932.

Journal de Médecine de Bordeaux et du Sud-Ouest. Bordeaux, Vol. CIX, No. 28, October 30, 1932.

The Journal of the Indian Medical Association. Calcutta, Vol. II, Nos. 1 and 2, September and October, 1932.

Bulletin of the National Tuberculosis Association. Vol. XVIII, Nos. 10, 11, and 12, October, November, and December, 1932.

Slovanský Sborník Ortopedický. Brno, Czechoslovakia, Vol. VII, No. 5, 1932.

Norsk Magasin for Laegevidenskapen. Oslo, Norway, Vol. XCIII, Nos. 10, 11, and 12, October, November, and December, 1932.

\* Final Report of The Commission on Medical Education. New York, 1932.

BEITRAG ZUR TECHNIK UND ORGANIZATION DER FRÜHEN KLUMPFUSSBEHANDLUNG (The Technique and Organization of the Early Treatment of Club-Foot). Patrik Haglund. *Acta Orthop. Scandinavica*, II, 233, 1932.

To the program outlined in his text-book in 1923, Professor Haglund suggests additions in the early management of congenital club-foot. He stresses the need of beginning vigorous treatment in early infancy and completely overcorrecting the feet at this time if a nearly normal foot is to be obtained. Only by avoiding recurrences can mutilating bone operations be avoided. The early treatment is now undertaken in two stages.

\* To be reviewed in a later issue.

At first the foot is brought into slight equinovalgus and maintained in this position by splinting. After the child begins to walk the deformity of the ankle joint is corrected by Achilles tenotomy. For feet with persistent intoeing further treatment is necessary. If the skeleton of the entire lower extremity is twisted inward, a rotation osteotomy of the tibia is indicated. If the deformity is due to incomplete correction of the foot deformity, the latter should be corrected. If paralysis of the peroneals is the complicating factor, it is advisable to balance the muscle power of the foot by early muscle transplantation.—*W. P. Blount, M.D., Milwaukee, Wisconsin.*

EIN BEITRAG ZUR KENNTNIS DER "(PSEUDO-) EXOSTOSIS DORSALIS ARTICUL. METATARSO-CUNEIFORMIS I" UND IHRER ENTSTEHUNG. Knut Bennet and Harry Hincsson. *Acta Orthop. Scandinavica*, II, 253, 1932.

The condition known colloquially as the "wooden shoe bump," and discussed scientifically as "(pseudo) exostosis dorsalis articul. metatarso-cuneiformis I," comprises two distinct entities. A primary bursitis, often of a bony hardness, arises from pressure of the foot gear and most frequently in cavus feet. A true exostosis may be the result of hypertrophic arthritis, usually in planovalgus feet. A bursitis may be secondary to the exostosis.—*W. P. Blount, M.D., Milwaukee, Wisconsin.*

ON THE DIAGNOSTIC AND THERAPEUTIC EMPLOYMENT OF NOVOCAIN INJECTIONS IN TRAUMATIC REFLEX CONTRACTURES. Sven Kiaer. *Acta Orthop. Scandinavica*, II, 273, 1932.

In those cases of contracture of the hand following scarring, novocain injection about the scar served a two-fold purpose. The influence of pain and reflex spasm was eliminated and the amount of true structural contracture determined. In addition there was lasting relief from pain, coldness, atrophy, with more or less increased mobility of the affected fingers. Surgical removal of the scar tissue was necessary in one case.—

*W. P. Blount, M.D., Milwaukee, Wisconsin.*

PRIMARY TUMORS OF THE OS CALCIS. A Study of Thirty-Two Cases with a Review of the Literature. Bradley L. Coley and George S. Sharp. *Am. J. Cancer*, XVI, 1053, Sept., 1932.

The authors have reviewed the literature of primary tumors of the os calcis, and have studied the material available in the Bone Tumor Department of the Memorial Hospital and in the Bone Sarcoma Registry of the American College of Surgeons, comprising thirty-two cases.

They emphasize the difficulty of establishing the diagnosis, owing to the atypical symptoms and signs, and the atypical roentgenographic appearance of tumors of the smaller bones. Biopsy is necessary in practically all cases, either by aspiration or surgical incision.

The treatment of osteogenic sarcoma is amputation; of endothelial myeloma, radiation; and of giant-cell tumor, especially if early before the cortex of the bone is destroyed, curettage followed by an escharotic.

Tumors of the os calcis are rare; diagnosis is almost invariably late; and the prognosis of malignant tumors is no better than that of similar tumors of other bones.

The report contains detailed case histories including photographs, roentgenograms, and photomicrographs of the five cases in the Memorial Hospital series.—*Grantley W. Taylor, M.D., Boston, Massachusetts.*

RADIOTHERAPY FOR ENDOTHELIAL MYELOMA. Arthor U. Desjardins. *Am. J. Cancer*, XVI, 1121, Sept., 1932.

The author discusses Ewing's tumor with special reference to its radiosensitiveness as of diagnostic significance. He states that such sensitiveness, when appropriate radia-

tion is given, is likely to establish the diagnosis more positively than can histological study, which is notoriously confusing in this field. His report is illustrated with photographs, roentgenograms, and photomicrographs of four representative cases from the total Mayo Clinic series of forty-three cases. The reports include some details of the radiation technique and dosage employed.—*Grantley W. Taylor, M.D., Boston, Massachusetts.*

**SOLITARY MYELOMA (PLASMACYTOMA) OF THE FEMUR.** Report of One Case. Warren G. Harding, 2nd, and Theodore S. Kimball. *Am. J. Cancer*, XVI, 1184, Sept., 1932.

The authors' case presented a tumor of the femur at the level of the lesser trochanter, which had caused a pathological fracture. The roentgenogram suggested the possibility of metastatic malignancy, although no other focus of disease was found elsewhere in the course of complete roentgenographic and postmortem examination. The pathological tissue showed a typical plasmacytoma in the microscopic sections. The paper is illustrated with roentgenograms, photographs of the specimen, and photomicrographs. A table is presented, showing some of the facts in the nine other cases reported in the literature.—*Grantley W. Taylor, M.D., Boston, Massachusetts.*

**FRACTURES AND EPIPHYSEAL SEPARATION FRACTURES OF THE ANKLE.** A Classification of 332 Cases According to the Mechanism of Their Production. Paul A. Bishop, *Am. J. Roentgenology*, XXVIII, 49, July, 1932.

An interesting and beautifully illustrated paper. The author's summary is the best review.

1. In the interest of a better understanding of the relationship of various fractures of the ankle, a classification based on the mechanism of such fractures is desirable.

2. The classification of Ashhurst and Bromer is suggested and reviewed as the one of greatest practical value.

3. Three hundred consecutive adult cases are subjected to this classification, with illustrations of the main types and their variations.

4. The influence of age on traumatic separation of the distal tibial and fibular epiphyses is discussed.

5. Roentgenograms are found to be of little value in diagnosing such injuries, in the absence of displacement, before the eighth year, due to the absence of visible osseous injury.

6. After the eighth year epiphyseal separation without osseous injury is rare, and after the fifteenth year epiphyseal injuries are rare, fractures being of the adult type.

7. Thirty-two cases of epiphyseal separation fractures are presented. These are considered as fractures of the ankle in which the line of fracture involves some part of the epiphyseal line, and are classified as to mechanism, each type presenting definite and characteristic features similar to the adult groups.—*Edward S. Hatch, M.D., New Orleans, Louisiana.*

**ROENTGENOLOGIC MANIFESTATIONS OF GIANT-CELL TUMOR.** B. R. Kirklin, and Claude Moore, *Am. J. Roentgenology*, XXVIII, 145, Aug., 1932.

This is a study of 110 cases of giant-cell tumors at the Mayo Clinic from 1909 to 1929. The diagnosis was proven by operation or biopsy in eighty-six cases; in twenty-four cases the clinical and roentgenological data sustained the diagnosis; two types were found.

The first or commonly described variety is a central tumor situated in the end of a long bone; it shows trabeculae and expands, but does not break through the cortex.

In the second type trabeculation is not seen; there is a homogeneous lysis of the affected area, the cortex is expanded and dissolved, and the mass projects into the soft tissues. This type is often mistaken for primary sarcoma or metastatic growth.—

*Edward S. Hatch, M.D., New Orleans, Louisiana.*

THE TREATMENT OF GIANT-CELL BONE TUMORS BY ROENTGEN IRRADIATION. George E. Pfahler, and Leo D. Parry, *Am. J. Roentgenology*, XXVIII, 151, Aug., 1932.

The roentgen ray in the treatment of these tumors has been used for twenty-five years. Before this the treatment was surgical.

The technique of the roentgen treatment is discussed and twenty-six cases are reported.

The authors feel that irradiation is definitely superior to surgery in the treatment of giant-cell tumors of bone.—*Edward S. Hatch, M.D., New Orleans, Louisiana.*

GIANT-CELL BONE TUMOR. A Consideration of the Morphology of This Neoplasm, the Response to Surgical and Radiation Therapy, and Report in Detail of Two Apparently Malignant Cases. Carleton B. Peirce, *Am. J. Roentgenology*, XXVIII, 167, Aug., 1932.

This extremely interesting and instructive paper analyzes nineteen cases of giant-cell tumor, two presenting malignant features. Roentgen therapy in repeated doses is considered the best treatment, though surgery is used in some cases. If surgery is used it should not follow x-ray therapy in less than six to eight weeks.—*Edward S. Hatch, M.D., New Orleans, Louisiana.*

HEMANGIOMA OF THE VERTEBRA. Jay Ireland, *Am. J. Roentgenology*, XXVIII, 372, Sept., 1932.

There have been only fourteen cases of hemangioma of the vertebrae reported, including the author's case. His is the second case diagnosed before operation or autopsy; most of the cases are symptomless. The author used radium therapy with success.—*Edward S. Hatch, M.D., New Orleans, Louisiana.*

LE CISTI DELLE OSSA LUNGHE (Cysts of the Long Bones). G. G. Forni, *Arch. di Ortop.*, XLVIII, 1, 1932.

The author presents an extensive review of the subject of cysts of the long bones and reports twenty treated cases. The most suitable classification of bone cysts is one based upon definite pathological processes. This classification, however, would not include a group of cysts of unknown or obscure etiology, such as osteitis fibrosa, osteitis deformans, and osseous dystrophies. Definite classification of these depends upon more accurate knowledge concerning the clinical symptoms, development, roentgen findings, and response to therapy.

In discussing the pathogenesis, the author notes that these cysts occur independently of the conditions of life or environment. A history of trauma to the affected bone was often obtained; nevertheless, the author finds it difficult to evaluate its importance. He reviews the various theories concerning the pathogenesis, including the neoplastic, osteitis fibrosa, osteodystrophy, inflammatory, traumatic, and endocrine theories.

In the differential diagnosis, Forni believes that a pathological fracture, occurring during adolescence, in the absence of other evidences of bone fragility, is practically pathognomonic of bone cyst and becomes more positive if there is a history of absence of or only mild pain and absence of functional disturbance.

After reviewing all the methods of treatment suggested, the author concludes that not all cysts should be explored. Small cysts which cause only mild pain should be kept under observation for evidences of progress or regression. If the cysts increase in size and are complicated by fracture, osteotomy with curettement of the cyst, then suture of the soft parts may be sufficient to promote healing. The intracystic hematoma that forms is a good stimulus to osteogenesis, which becomes even more active if bone fragments from the cortex are introduced into the cavity. Tamponage of the cavity is not advised, since it retards cicatrization and facilitates secondary infection. Fat transplants have not been successful in the author's hands. Large cysts, complicated by one or more

fractures, are best treated by osteotomy and curettage of the cavity, followed by massive bone transplants preferably from the tibia, with molding of the cyst wall about the transplant. The author obtained the best functional and anatomical results by this procedure. If the cyst progresses in spite of this procedure, a segmental resection of the cyst is advised. Although some cysts seem to get well without surgical intervention, these may lead to considerable disability due to shortening or deformity.

Roentgen therapy is based on too few observations and indefinite results to be advised. The author gives a detailed report of his twenty cases accompanied by roentgenograms.—*Peter A. Rosi, M.D., Chicago, Illinois.*

**SUL METATARSO VARO CONGENITO (Congenital Metatarsovarus).** S. L. Carnevali, *Arch. di Ortop.*, XLVIII, 181, 1932.

Carnevali reviews the cases of congenital metatarsovarus treated at the Pio Istituto Rachitici of Milan. He differentiates metatarsovarus in which there is an external convexity and an adduction of the metatarsal bones from metatarso-adductus in which there is only an adduction of the metatarsals without deformity of the diaphysis. Both conditions are considered as different stages of the same disease. Metatarso-adductus is in all probability the primary stage, and its apparent rarity and occurrence in very young children tends to substantiate this conception.

The author discusses the various theories concerning the etiology of metatarsovarus. He believes that the older theory of intra-uterine mechanical disturbance is the most acceptable.

Adduction of the anterior part of the foot, with a pronounced external convexity and an exaggerated internal concavity, is the characteristic deformity of metatarsovarus. The plantar surface is usually rotated medially in younger infants, whereas, after the child walks, a more or less pronounced pes cavus develops. There is little change in the position of the calcaneum. Difficulty in walking is often the only symptom. Pain is infrequent.

Roentgenological examination reveals only a few cases in which there is an alteration in the relation or form of the tarsal bones. The most important finding was an alteration of the long axis of the cuneiform to an oblique posterior internal and anterior external position.

The author discusses the proposed methods of treatment of metatarsovarus. In the cases treated at the Pio Istituto Rachitici the best results were obtained by closed manipulations with fixation in plaster-of-Paris casts, followed by suitable orthopaedic shoes. When instituted early, this course of treatment offers good results.—*Peter A. Rosi, M.D., Chicago, Illinois.*

**SCOLIOSI CON PARAPLEGIA (Scoliosis with Paraplegia).** A. Viganò. *Arch. di Ortop.*, XLVIII, 253, 1932.

The author reports a case which he classes as one of the unusual types of severe scoliosis, usually of the congenital type, which may cause no disturbance until adolescence when a spastic paraplegia suddenly develops, with derangement of the sphincters and occasionally severe sensory disturbances. Characteristically this paraplegia comes on without any apparent cause, such as trauma or infection.

The cause of the transverse lesion of the cord is not known but is believed to be due to the disturbances resulting from the abnormal differential growth of the vertebral canal and the spinal cord in the thoracic region, these disturbances, for the most part, being in the blood or lymph vessels. Laminectomy by relieving the pressure or increasing the size of the vertebral canal allows free circulation and recovery, for apparently no actual nerve degeneration takes place for a long time. Only about eighteen cases have been reported in the literature. The authenticity of the author's case depends upon further observation, because laminectomy, although advised, was refused.—*A. Louis Rosi, M.D., Chicago, Illinois.*

RECONSTRUCTION OF FOREARM AFTER LOSS OF RADIUS. H. H. Greenwood. *British J. Surg.*, XX, 58, July, 1932.

In the case described, the loss of a portion of the radius resulted from osteomyelitis. One year later there was marked deformity of the forearm. This deformity was corrected by a very ingenious operation which consisted of first replacing the soft parts by a tubular graft and then using a portion of the ulna to stabilize the lower end of the radius. An oblique osteotomy was done in the ulna, the upper fragment set into a notch made in the isolated lower end of the radius and the lower ulnar fragment united to the shaft of the radius making a Y. This gave a stable wrist joint and allowed the boy to develop normally and later to do laborious manual work.

A NOTE ON THE MOVEMENTS OF THE SHOULDER-JOINT. C. P. Martin. *British J. Surg.*, XX, 61, July, 1932.

Abduction of the arm is a complicated movement consisting of true abduction of the humerus at the humeroscapular joint combined with rotation of the scapula and elevation of the clavicle. The writer believes that it is not recognized that, in addition to these movements, there is also a lateral rotation of the humerus to over ninety degrees. A certain amount takes place during the first half of abduction, but for the most part as the arm is raised from the horizontal to the upright position. This is of importance in shoulder-joint disabilities, for frequently the blame is laid on lack of power to abduct, when in reality the lateral rotation is at fault.

A REPORT ON THE STRANGWAYS COLLECTION OF RHEUMATOID JOINTS IN THE MUSEUM OF THE ROYAL COLLEGE OF SURGEONS. R. Lawford Knaggs. *British J. Surg.*, XX, 113, July, 1932.

This collection was made by Dr. Strangeways, a pathologist at St. Bartholomew's Hospital, during the years 1905 to 1914. This report is made after a very careful study of all this material. It deals with osteo-arthritis, rheumatoid arthritis, gout, fibrous and bony ankylosis, and Charcot's disease. The clinical and pathological studies are correlated and certain deductions are made from the study. The article is illustrated by excellent photomicrographs.

RADIOGRAPHIC INVESTIGATION OF LUMBAR AND SCIATIC PAIN. James F. Brailsford. *British Med. J.*, II, 827, Nov. 5, 1932.

Brailsford discusses the important value of x-rays in the diagnosis of low back pain. The article deals only with x-ray findings in this disease. Congenital and developmental abnormalities he finds frequently (twenty-five per cent), but of doubtful significance in the explanation of the patient's symptoms. Trauma accounts for many cases of painful back and often the x-ray reveals clear evidence of the disease. He rightly points out that often the disability of which the patient complains is out of all proportion to the x-ray findings. Toxaemia giving rise to local changes, the spine accounts for the largest proportion of cases. X-ray often reveals clear-cut evidence of this type of spinal disease or of the focal infection (e.g. dental apical abscess) which has given rise to it. Inflammatory condition and tumors account for a smaller proportion of cases.—R. I. Harris, M.B., Toronto, Canada.

CONGENITAL ABSENCE OF HEAD OF FEMUR. Alex Brownlee. *British Med. J.*, II, 835, Nov. 5, 1932.

This is the report of a congenital anomaly of development of the head of the femur occurring in two members of a family with an associated lesion in a third member. Strictly speaking, the cases do not represent absence of the head of the femur, but rather



delayed and abnormal ossification of the upper femoral epiphysis. The result is not unlike Legg's disease but arising congenitally.—*R. I. Harris, M.B., Toronto, Canada.*

REMARKS ON CLINICAL APPLICATIONS OF THE RECENT WORK ON BONE DISEASE. Edward Mellanby. *British Med. J.*, II, 865, Nov. 12, 1932.

Mellanby ably summarizes recent work which has increased our knowledge of bone physiology and bone disease and has permitted more rational treatment. The two lines of investigation which have yielded the greatest knowledge of bone physiology and disease are: (1) the influence of dietetic and environmental factors on bone disease; and (2) the rôle of the parathyroids. Mellanby's paper presents a clear picture of our present knowledge of bone physiology,—rickets, osteomalacia, osteitis fibrosa cystica, Paget's disease of bone, and renal rickets.—*R. I. Harris, M.B., Toronto, Canada.*

ÜBER DIE OSTEOMYELITIS DER WIRBELSÄULE. (Osteomyelitis of the Spine.) S. Lenner, *Bruns' Beitr. z. Klin. Chir.*, CLV, 223, 1932.

Four cases are reported of which two were acute, one was subacute, and one chronic. All were primary cases, occurring in males from twenty to forty years of age. In one acute case and one chronic case the vertebral body was affected, and in the remaining two cases the disease process was located in the spinous process.

The roentgenogram does not reveal any information in the early case. In one instance a mediastinal abscess was noted nine days after the onset of the disease. In later stages it reveals destruction of bone. However the shadows due to new bone formation characteristic of osteomyelitis are not detected for a relatively long period of time after onset. Yet, in spite of that, the histological examination shows an extensive formation of new osteoid tissue which is as yet poorly calcified.

The final proof for the diagnosis is the demonstration of the bacteria, which is usually not possible before operation. The most common agent is the staphylococcus aureus.

Sequestration is not seen either clinically or roentgenographically.

Treatment consists of radical removal of diseased tissues. When the vertebral body is affected, one must be content with drainage of the abscess and immobilization of the spine.—*R. J. Diltrich, M.D., Fort Scott, Kansas.*

ÜBER SPONDYLOLISTHESIS. Hans Schaer. *Bruns' Beitr. z. Klin. Chir.*, CLV, 287, 1932.

Following a review of the literature on spondylolisthesis, the author discusses the controversial views regarding the etiology of this condition, particularly the question of the associated trauma as a causative factor.

Spondylolisthesis is not to be conceived as a maldevelopment due to arrest, which may be explained by the failure of two bone centers to form an osseous union. Rather it represents an obvious maldevelopment in the sense that the presence of two bone centers in one half of the vertebral arch is of itself an anomaly.

In the diagnosis of a spondylolisthesis of the fourth lumbar vertebra it must be noted whether the vertebra which appears to be the fifth lumbar is not in reality a lumbarized sacral vertebra. With this anomaly the slipping occurs, as a rule, between the fifth lumbar and the lumbarized first sacral, because the firm union between this transitional vertebra and the second sacral does not permit a slipping. At first glance, this anomaly may simulate a slipping of the fourth lumbar vertebra.

Similarly, in a spondylolisthesis of the fourth lumbar, we find not infrequently a sacralization of the fifth lumbar vertebra. For the same reason as above, a slipping, if it occurs at all, is much easier between the fourth and fifth lumbar vertebrae than it is between the fifth lumbar and first sacral, because, as a result of the sacralization, the fifth lumbar and the first sacral would be more firmly united than the fourth and fifth lumbar vertebrae.

Spina bifida occulta is such a common anomaly, either with or without spondylolisthesis, that, etiologically, it is not important.

Five case reports are included in this article.—*R. J. Diltrich, M.D., Fort Scott, Kansas.*

DISLOCATION OF THE ASTRAGALUS. S. L. Haas. *California and Western Med.*, XXXVII, 176, Sept., 1932.

The author discusses the frequency of dislocation of the astragaloscaphoid joint, the mechanism of production of the various forms of luxation, and the necessity of x-ray views for diagnosis. To reduce, the foot is flexed plantarward if the head of the talus is displaced downward, and dorsally when the head is luxated upward. Pressure is made upon the head and additional lateral movements may be necessary. The prognosis is favorable, though complications—such as arthritis, necrosis of skin, or gangrene of the foot—may follow.

One case complicated by fractures of the fibula and cuboid is reported.—*Charles Lyle Hawk, M.D., Los Angeles, California.*

DIE ENTSTEHUNGSURSACHE DER PSEUDARTHROSE NACH BRUCH DES KAHNBEINS DER HAND. (Cause of Pseudarthrosis Formation Following Fracture of the Carpal Navicular.) H. Lützel. *Deutsche Ztschr. f. Chir.*, CCXXXV, 450, 1932.

The analysis of 117 cases of fresh fracture and fourteen cases of pseudarthrosis of the carpal navicular bone, together with anatomical studies of the blood supply of this bone, has led to the following conclusions:

Fracture of the carpal navicular shows a tendency to pseudarthrosis formation only when a smooth transverse fracture occurs through the middle of the body of this bone. This was demonstrated by x-ray examination.

It was shown by injection of blood vessels that the distal and the proximal halves of the navicular are so well supplied with blood vessels that, in case of fracture, it is impossible to have the blood supply cut off from either of the fragments. Each half of the bone has its own vascular system, and the vessels of the two halves anastomose freely, intra-osseously and extra-osseously.

The fracture which has a tendency to pseudarthrosis formation occurs partly in areas which are covered by joint cartilage. This provides for a weakness of the callus which, however, leads to pseudarthrosis formation only in transverse fractures through the middle of the bone, because only in this type of fracture can harmful mechanical influences act on the callus. These harmful influences consist of traction of the tense capsule and ligaments, even when the hand is immobilized, but are more pronounced during movement.

Prolonged immobilization is necessary only in case of a smooth transverse fracture through the middle of the body of this bone. All other fractures heal by bony union, with immobilization for two to three weeks and physiotherapeutic after-treatment.—

*R. J. Diltrich, M.D., Fort Scott, Kansas.*

ANATOMIE UND KLINIK DER LUMBOSACRALEN ÜBERGANGSWIRBEL (SAKRALISATION UND LUMBALISATION). [Anatomical and Clinical Study of the Lumbosacral Transition Vertebra (Sacralization and Lumbarization).] Carl Blumensaat und Carl Clasing, *Ergebn. d. Chir. u. Orthop.*, XXV, 1, 1932.

An analysis is made of the anatomical and clinical features of variations in the lumbosacral region. This article contains a very careful and extensive review of the literature on the subject, in addition to the studies made by the authors.

A nerve injury by compression, with sacralization of the fifth lumbar vertebra, is improbable, both from anatomical investigations and on the basis of development.

In the neurological examination of thirty patients such injury could not be demonstrated. In some cases of sacralization, the nearthrosis may be the seat of a deforming arthritis, which is occasionally the cause of complaints. With a high-grade asymmetry of the vertebra, disability results, in exceptional cases, on the basis of a static-dynamic decompensation. Among ninety patients with lumbosacral transitional vertebrae, only three had disability which could reasonably be attributed to the asymmetry.—*R. J. Dittrich, M.D., Fort Scott, Kansas.*

RÉSULTATS ÉLOIGNÉS DE L'ARTHRODÈSE EXTRA-ARTICULAIRE DE LA HANCHE "POUR COXALGIE" CHEZ L'ADULTE. (Extra-Articular Arthrodesis of the Hip for Coxitis in Adults.) A. Contargyris. *La Grèce Médicale*, XXXI, 89, 1932.

The author reports four cases of coxitis in adults, operated on by extra-articular arthrodesis, the results of which were good and permanent for one and one-half years to five years after the operation. In three of the cases the disease was old; in the other it was in the acute stage. The satisfactory result obtained in this latter case with a spontaneous arthrodesis allowed him to consider that extra-articular arthrodesis could be used in this disease on the more active as well as the old cases.

THE TREATMENT OF CONGENITAL CLUBFEET. J. H. Kite. *J. Am. Med. Assn.*, XCIX, 1156, 1932.

The author's purpose in the following study of over 200 club feet is to determine: first, the efficiency of certain methods of treating these feet as judged by a study of the results and, second, to determine some of the factors that have influenced the treatment.

His series of cases are divided into three groups; the first consists of feet that have been treated by various operative procedures prior to the development of the "non-operative" method. The second group consists of a large group of patients treated by the slow plaster correction method, and the last group consists of patients who had open operations done on the bone structure of the foot.

He notes in his discussion of the operative correction of club feet the danger of gangrene to the feet and toes as a result of stretching the posterior tibial artery too much in the forcible operative corrections. He further notes that correction in boys is longer on the average than it is in girls.—*H. E. Hipps, M.D., Dallas, Texas.*

PROBLEMS OF ADMINISTRATION IN INDUSTRIAL SURGERY. Lloyd Noland. *J. Am. Med. Assn.*, XCIX, 1215, 1932.

Dr. Noland, who is chief surgeon for the Tennessee Coal, Iron, and Railroad Company, gives a comprehensive study of the development of the present efficient medical department of the Company. A number of diagnoses are given, illustrating that under proper light and ventilated working quarters and proper sanitary living quarters, both employer and employee benefit.

It is estimated that from six to seven per cent. of industrial absenteeism is due to accidents, three per cent. to occupational diseases, and ninety per cent. to ordinary sickness.

The labor turnover for the year 1919 was 145.3 per cent. and in 1930 was 5.1 per cent. The Company now requires immunization against typhoid, small pox, and diphtheria.

Employed by the company are fifteen dentists and twenty-five doctors, all on full-time basis. The company maintains, in addition to several field units and a sanitary corps, a base hospital having 310 beds.—*P. M. Girard, M.D., Dallas, Texas.*

CONGENITAL ELEVATION OF SCAPULA AND PARALYSIS OF SERRATUS MAGNUS MUSCLE. OPERATION. Armitage Whitman. *J. Am. Med. Assn.*, XCIX, 1332, 1932.

The author presents a very ingenious operation for stabilizing the scapula after it has been brought down in the correction of Sprengel's deformity and which likewise may

be used most successfully in cases of paralysis of the serratus anterior. He does not use a rib to anchor the scapula to, as it is a mobile anchorage and is not, therefore, always successful. In his operation the edge of the scapula is anchored to the spinous processes of the dorsal vertebrae. The details are fully described in his paper. He also presents a complication to the operation of correction of Sprengel's deformity that has not hitherto been reported in the literature.

One case of Sprengel's deformity and one case of serratus anterior paralysis, which have been operated upon as long as three years, are presented. Both of these patients now have excellent function.—*H. E. Hips, M.D., Dallas, Texas.*

L'ABLATION TEMPORAIRE ET LA REPOSITION DE LA MALLÉOLE PÉRONIÈRE DANS LE TRAITEMENT OPÉATOIRE DE CERTAIN CALS VICIEUX DU COU-DE-PIED (Temporary Removal and Reposition of the External Malleolus in the Operative Treatment of Certain Cases of Malunion at the Ankle). A. Basset. *J. de Chir.*, XXXIX, 487, 1932.

In fractures of the external malleolus which have united with the fragment in poor position and the astragalus displaced either anteriorly or outwardly, the author advises removal of the external malleolus and fixation of the malleolus to the lateral surface of the tibia. The bone is exposed through a curved incision, about eight inches long, which passes downward behind the fibula, and curves forward under the malleolus. If the fracture is fairly recent, the fracture line is separated and the lower fragment is dissected out and removed. If it is old, the shaft of the fibula is cut. The deep surface of the malleolus is then cleared of fibrous tissue and chiseled smooth, and the fibrous tissue and callus are removed from the lateral surface of the tibia and raw bone exposed. The removal of the malleolus exposes the ankle joint and enables the surgeon to replace the astragalus in normal position. If the internal malleolus has been fractured and is displaced, it is exposed by a separate incision and the distal fragment is freed and replaced in its normal position. The loose external malleolus is then fixed to the lower end of the tibia by one or two wood screws and the wound is closed. A plaster cast is left on for about eight weeks. By this operation the author creates a true bimalleolar tibia. He reports three cases with good results.—*J. Albert Key, M.D., St. Louis, Missouri.*

SUR UNE VOIE D'ACCÈS POSTÉRIEURE DE L' OMOPLATE (Posterior Exposure of the Scapula: Its Application to the Treatment of Fractures of the Neck of the Scapula). R. Dupont et Henri Evrard. *J. de Chir.*, XXXIX, 528, 1932.

The authors describe a posterior incision for the exposure of the neck, mesial border, and body of the scapula. With the patient lying on the face and the affected arm elevated and supported by sand bags, an incision about eight inches long is made along the posterior border of the deltoid. This incision crosses the axillary border of the scapula in its middle third and extends posteriorly to the vertebral border of this bone. The deltoid and latissimus dorsi are separated, and the incision is carried down between the rhomboid major and the rhomboid minor. These muscles are retracted to expose the vertebral border of the scapula and with a periosteal elevator the tissues are elevated from the bone. The scapular origin of the triceps lies in the depths of the wound and protects the circumflex vessels and nerves from injury. Care must be taken not to damage the inferior scapular vessels because, if they are cut, it is difficult to control hemorrhage in the depths of the wound. After the border of the scapula is exposed, the soft tissues are freed from the bone with a periosteal elevator and it is possible to expose the posterior glenoid and the lower half of the anterior border of the glenoid. Likewise, the muscles can be elevated to expose the posterior portion of the neck and body of the scapula. The authors report one case of fracture of the neck of the scapula in which this incision was used with satisfactory results.—*J. Albert Key, M.D., St. Louis, Missouri.*

SUR QUELQUES POINTS DE TECHNIQUE DANS LES GREFFES VERTÉBRALES. (Some Points of Technique in Vertebral Grafts.) Y. Picot. *J. de Méd. de Bordeaux*, CIX, No. 7, 196, 1932.

A résumé of some facts on the technique of vertebral bone graft. Dr. Picot speaks of some of the disadvantages of the Albee grafts and prefers the osteoperiosteal grafts buried deeply under the muscles over the laminae of the vertebrae. The points in technique which he suggests are: a long incision parallel to the spinous processes; a thorough exposure of the vertebral laminae by elevation of the attachment of the muscles by a kind of trough made in the laminae to hold the grafts, which is made by a specially devised instrument described by the author. The graft is removed from the tibia, usually the entire face of the tibia, and is divided into two portions to be used on either side of the spinous processes. The grafts are firmly secured in place by catgut sutures. No fixation apparatus is used. Sixteen cases with excellent results are reported.

UN CAS D'ARRACHEMENT DE L'ÉPINE TIBIALE. (A case of Fracture of the Tibial Spine.) Y. Picot. *J. de Méd. de Bordeaux*, CIX, No. 7, 200, 1932.

Dr. Picot reports a case of fracture of the tibial spine with subsequent swelling, hydrarthrosis, and thickening of the capsule, which had been considered and treated as tuberculosis because of these symptoms. The patient was a girl of sixteen years and the accident had taken place a year previously. The roentgenograms, taken at the time, showed a slight amount of atrophy with a small erosion in the region of the center of the tibial area, without any actual foreign body. The lateral view, taken three months later, showed very clearly a small foreign body which represented the fractured tibial spine. This foreign body was later removed. The case was reported to emphasize the need of recognizing the development of joint symptoms, following trauma to the knee, which are frequently mistaken for tuberculosis, and also the need of a sufficient number of roentgenograms to determine the presence of a foreign body.

ANTERIOR POLIOMYELITIS, WITH SPECIAL REFERENCE TO PATIENTS PASSED THROUGH THE ROYAL ALEXANDRIA HOSPITAL FOR CHILDREN IN RECENT EPIDEMICS. J. Steigrad. *Med. J. Australia*, I, 785, June 4, 1932.

The observations are from 250 acute cases during the past four years. The age incidence was largest in children from one to four years old with ten cases under one year.

The symptoms most frequently observed were drowsiness or irritability (in nearly every case) and, in over fifty per cent., fever, vomiting, spine sign, and neck rigidity. The spine sign is probably present in over seventy per cent. of early cases and consists of the production of pain on flexing the spine. Amos's sign or the "tripod sign" consists of placing the hands on bed behind the buttocks, when the patient is required to sit up; the two arms and the trunk forming a tripod. This sign is frequently seen in older children.

Lack of uniformity of the deep reflexes is very suggestive. Some cases commence with convulsions, stupor, or unconsciousness; the tendency of this type is toward complete recovery. The author considers the cerebrospinal fluid cell count of extreme value, the average count in his cases being eighty cells per cubic centimeter.

The prognosis is moderately good, more than half of the cases recovering completely. In the bulbar and pontine form those with involvement of the vital centers usually die, while those with the facial paralyses recover. In the cerebral, cerebellar, and meningitic forms the prognosis is good.

The author recognized the following forms:

The abortive; spinal (the most common form); bulbar and pontine, involving muscles in the brain stem; cerebral, with convulsions, aberrations of speech, choreic and athetoid movements, etc.; cerebellar, with marked incoordination; and the ascending and descending form, or Landry's paralysis.

In the treatment, convalescent serum was used freely, but the author withholds judgment as to its value, although very optimistic as to its probable usefulness when its technique is completely worked out.—*Edward N. Reed, M.D., Santa Monica, California.*

ANTERIOR DISLOCATION AND SUBLUXATION OF THE ASTRAGALUS. A. J. Sheftel. *Orthopaedia i Travmatologia*. V, 11, 1931.

Dislocations of the astragalus are rare. The author has not found any references to dislocation or subluxation of the astragalus in the entire Russian orthopaedic literature between 1914 and 1926. The author produced experimentally different degrees of astragalus dislocation on cadavera. For mild subluxations a tear of the capsule is sufficient; a complete dislocation requires a complete destruction of the anterior and posterior lateral ligaments, the severance of the extensor tendons and the astragalocalcaneal, astragalonavicular and astragalocrural ligaments. The x-rays of the author's specimens did not reveal the actual relationship of the experimentally displaced bones. The author believes that subluxations are more frequent than dislocations; subluxations are frequently mistaken for fractures about the ankle joint. X-ray diagnosis of the partial anterior displacement of the astragalus may lead to errors in interpretation and a study in three directions is therefore necessary. The author reports a case and further describes the typical position of the foot with anterior subluxation of the astragalus.—*Emanuel Kaplan, M.D., New York, N. Y.*

NEW INTERPRETATION OF THE PATHOGENESIS AND SURGERY OF PAIN IN CALCANEAL SPUR. L. A. Shilnikov. *Orthopaedia i Travmatologia*. VI, 111, 1931.

Many experimental and clinical facts established at the Institute of Surgical Neuropathology, as well as elsewhere, lead to a definite relationship between neuromata and neuritis, and osteoporotic changes and bones. The calcaneal spur is a result of a neurotrophic disturbance of certain branches of the sciatic nerve, producing a decalcification of the os calcis. The muscle pull on the softened osseous structures of the os calcis creates a subplantar or achillean spur. This spur is a soft decalcinated structure. Calcaneodynia in the presence of a calcaneal spur is an expression of a neuritis and is not produced by the spur. Thus, there are spurs not accompanied by pain and, vice versa, pain in the heel is very often not coexistent with a spur. It was found by the author that a neuritis of the nervus cutaneous surae medialis and nervus suralis are responsible for the calcaneal-spur syndrome. After a neurotomy of one of these branches, the usually soft spur shows more calcification and becomes eburnated; the calcaneodynia disappears. The author had eight cases of neurotomy for calcaneodynia in which there was a 100 per cent. improvement after a period of from four to forty-nine months. Achillodynia is not improved by neurotomy of the above mentioned nerves. The surgical removal of calcaneal spur, which frequently aggravates the calcaneodynia, should be discontinued and replaced by the much simpler neurotomy of the nervus suralis or nervus cutaneous surae medialis.—*Emanuel Kaplan, M.D., New York, N. Y.*

DE LA VALEUR THÉRAPEUTIQUE DES INFILTRATIONS PÉRI-ARTICULAIRES À LA NOVOCAÏNE DANS LES ENTORSES ET LES ARTHRITES TRAUMATIQUES. René Leriche et René Fontaine. *Presse Méd.*, XL, 280, 1932.

The authors inject a one per cent. solution of novocain into the periarticular tissues of the affected shoulder, sometimes daily, sometimes less frequently. The ability to abduct the arm voluntarily returns as soon as anaesthesia is established, but again disappears. After the injections have been repeated at daily (or less frequent) intervals, painless abduction finally supervenes.

Only three cases are reported, all with the diagnosis of traumatic arthritis including two of recent origin.

The method would seem equally promising in the condition we Americans call peri-arthritis of the shoulder. The authors suggest the use of this method in after-treatment of fractures involving the shoulder joint.

The ability and prominence of the authors combined with the simplicity and safety of the procedure would seem to recommend a trial.—*Emil S. Geist, M.D., Minneapolis, Minnesota.*

MALADIES OSSEUSES ET TROUBLES DU MÉTABOLISME CALCIQUE. P. Delmas-Marsalet. *Presse Méd.*, XL, 282, 1932.

This seems to be an important contribution. It is a report of the cure of a case of Paget's disease and another of von Recklinghausen's disease. These cases are fully reported and adequately illustrated by roentgenograms.

In the latter disease the authors recommend trial of their conservative drug treatment before resorting to a parathyroidectomy. In cases of this type the authors recommend a trial of the following treatment to be used for a period of at least six months' duration:

First, vitamin D dissolved in oil; the daily portion being 7500 units; this amount to be divided and taken in cold milk in two daily doses. Second, three teaspoonfuls of calcium gluconate daily (about twelve grams).

Three times during each week an intramuscular injection of one grain of calcium gluconate in a ten per cent. solution.

Control roentgenograms every three months.

The authors suggest administration of this therapy in osteomalacia and leontiasis ossea.—*Emil S. Geist, M.D., Minneapolis, Minnesota.*

LES HALLUX VALGUS. Hallux Valgus de Posture et Hallux Valgus Inflammatoire. Mathieu-Pierre Weil et J. Delarue. *Presse Méd.*, XL, 586, 1932.

The authors distinguish between postural hallux valgus and that of the arthritic type. There are convincing illustrations. The problem is considered from the viewpoint of the anatomo-pathologist.—*Emil S. Geist, M.D., Minneapolis, Minnesota.*

LES FORMES FRUSTES DE LA COXA-VARA DES ADOLESCENTS. F. Pouzet. *Presse Méd.*, XL, 1352, Sept. 3, 1932.

A report of six cases of what we are now in the habit of calling "slipped epiphysis". In addition to the usual abduction treatment the author calls attention to the necessity of internal therapeusis in cases of this category (endocrines, calcifiants, irradiated sterols).—*Emil S. Geist, M.D., Minneapolis, Minnesota.*

L'APPAREIL OUATÉ DE DUJARIER DANS LES FRACTURES DE L'HUMÉRUS. Georges Rouhier et Pierre Labignette. *Presse Méd.*, XL, 1418, Sept. 17, 1932.

A rather simple and ingenious method for obtaining fixation in fractures of the humeral shaft. The authors use a voluminous amount of absorbent cotton and muslin bandages and nothing else. When properly applied this makes a firm and adequate splint. The method is based on the same principle as that described by Schanz of Dresden in using the same materials in splinting the neck.—*Emil S. Geist, M.D., Minneapolis, Minnesota.*

PECULIAR REGENERATION OF BONE, FOLLOWING MAGGOT TREATMENT OF OSTEOMYELITIS. M. M. Pomeranz. *Radiology*, XIX, 212, Oct., 1932.

The healing process in osteomyelitic bone following maggot therapy is typical and presents three stages:

First, an exudative stage, noted seven to ten days after saucerization, an osteoplastic process. Material approximating the density, but lacking the homogeneity of callus, filling the excavated zone and extending into the overlying soft tissues.

After two to four weeks the second or contractile stage begins. In this stage the callus-like mass contracts down, to reestablish the approximate caliber of the shaft, and becomes as dense as the bone itself. At this time there is no differentiation between medulla and cortex.

The terminal stage is reached about six months after operation, the entire excavated area and contiguous medulla being filled with dense eburnated bone.

The whole process resembles callus formation. The author feels that "it is permissible to conclude that healing is more rapid and that the end product approximates more closely normal bone structure than any of the hitherto accepted methods of treatment".—*Edward N. Reed, M.D., Santa Monica, California.*

LA TARSOCLASIA MODELANTE EN EL TRATAMIENTO DE LOS PIES BOT VAROS EQUINOS SUPINADOS CONGÉNITOS INVETERADOS. José Valls y Carlos E. Ottolenghi. *Revista de Ortopedia y Traumatología* (Buenos Aires), I, 515, April, 1932.

The authors bring up for discussion the question of the selection of treatment for old, inveterate club feet. The German Orthopaedic Society in 1932 and the French Orthopaedic Society in 1931, have had this problem presented in their respective meetings, without arriving at any definite conclusions; two very well opposed tendencies prevailed as had happened in previous meetings. The authors, after a complete review of the different surgical procedures and their criticism, pronounce themselves in favor of osteoclasis, adding, when it seems necessary, tenotomy or lengthening of the tendo achillis, plantar fasciotomy, or subastragaloid arthrodesis. The paper is illustrated with clinical histories, roentgenograms, and photographs of three very interesting cases.—

*Alberto Inclan, M.D., Havana, Cuba.*

A PROPOSITO DO TRATAMENTO DAS FRACTURAS DO ANTEBRAÇO NAS CRIANÇAS. Barros Lima. *Revista de Ortopedia y Traumatología* (Buenos Aires), I, 495, Apr., 1932.

The author presents the subject of the treatment of fractures of the forearm in children, discussing the advantages of the different procedures recommended for this type of lesion. On account of the pathology found at the site of fracture, the irregular, dentate surface presented by the fragments, and the separation of the periosteum from the ends of the fragments offering great difficulty for the manual reduction of these fractures, Lima recommends the open reduction and apposition of the fragments without any type of internal fixation. In most of his cases the author has decided on the operative procedure, after manual attempt at reduction had failed. In transverse fractures, the existing indentations at the line of fracture are sufficient to maintain the reduction obtained by the open alignment of the fragments; otherwise these indentations can be made by the surgeon in order to obtain the locking of the fragments, as advised by Soresi and Demel. The author presents the clinical histories of thirteen patients treated by him by open reduction and external fixation with plaster splints.—*Alberto Inclan, M.D., Havana, Cuba.*

VIAS DE ACCESO A LA ARTICULACIÓN DE LA CADERA. (Surgical Approaches to the Hip Joint.) Guillermo Allende. *Revista de Ortopedia y Traumatología*, II, 1, July, 1932.

The author presents a very complete study of the matter. A résumé of the history of surgery of the hip joint and the anatomy of the latter is first offered, and a thorough description of the multiple ways of approach to the hip joint follows. The most important part of this paper is the author's experience and advice on the indications for each method, and he presents several of his own cases to illustrate his conclusions. The pos-



terior approach is recommended for all cases of pyogenic infections of the hip in which drainage of the joint is necessary. In all the cases of hip conditions demanding plastic or reconstructive surgery, the anterior or the lateral approaches are advised; in many instances the Smith-Petersen or the Mathieu techniques, combining both ways of approach, are recommended as the best choice.—*Alberto Inclan, M.D., Havana, Cuba.*

LES ARTHRITES CHRONIQUES AMICROBIENNES DE LA HANCHE (Amicrobial Arthritis of the Hip). R. Massart. *Rev. de Chir.*, LI, 162, 1932.

Under this heading the author considers arthritic conditions developing during adult life in hips which were subjected to disease or injury in early life and in those which have not been subjected to previous injury or disease. He first considers the late changes in congenital dislocation of the hip and points out the fact that those hips in which no attempt has been made at reduction and in which a false acetabulum has not developed do not tend to be painful, while those in which anterior transposition has been performed, or in which a false acetabulum has been formed either naturally or by surgical means, as well as a certain percentage of those in which a satisfactory reduction has been obtained, do tend to develop chronic arthritis and tend to become painful. He also notes that subluxation of the hip (coxa valga) is apt to result in chronic arthritic conditions in later life. The same is true of the coxa vara deformities either from rickets or of congenital origin and also of the adolescent coxa vara in which the upper epiphysis of the femur has been displaced. It is interesting to note that he does not consider Legg-Perthes' disease as a frequent cause of arthritis in later life because he believes that this condition occurs so early that the acetabulum becomes adapted to the head of the femur. He cites two cases of unrecognized fracture of the neck of the femur, healed with slight deformity, in which chronic arthritis developed. Finally he takes up the chronic arthritis of the hip which develops during late adult life (morbus coxae senilis) and believes that the primary factor in this condition is a softening of the head of the femur.—*J. Albert Key, M.D., St. Louis, Missouri.*

LES ACCIDENTS NERVEUX DE LA RÉDUCTION DE LA LUXATION CONGÉNITALE DE LA HANCHE. (Nerve Injuries in Reduction of Congenital Dislocations of the Hip.) P. Corret. *Rev. d'Orthop.*, XIX, 5, 1932.

The author reports six cases of peripheral nerve injury and four cases of injury to the central nervous system which occurred in over 2600 reductions of congenital dislocations in Froelich's clinic. He notes that the accident of injury to the sciatic nerve is especially apt to occur in patients from five to nine years old in whom the head is unusually high and in whom the acetabulum is clear-cut with well defined margins. According to Froelich, the impression is that in these cases the head of the femur has never rested in the acetabulum and that they appear to be true embryonic dislocations. There are no postmortem specimens, but dissections of infants indicate that the paralysis of the sciatic is produced in part by hyperflexion and traction and in part by compression of the sciatic nerve between the head of the femur and ischium. The diagnosis is easily made from the foot drop and the vascular dilation of the extremity. The peroneal nerve is more severely injured than is the tibial. Apparently the nerves are not torn and, in most cases, recovery of function occurs in from six months to a year, although cases have been recorded in which the paralysis has been permanent. The cerebral injuries with convulsions and coma are obscure in origin and are thought to result from emboli. The treatment of the peripheral nerve paralysis is conservative. That of the cerebral injuries is also conservative. Two of the four patients with cerebral injuries died.—*J. Albert Key, M.D., St. Louis, Missouri.*

LES PÉRIARTHROSES TRAUMATIQUES. (Traumatic Peri-Arthritis.) R. Pétrignani. *Rev. d'Orthop.*, XLIX, 101, 1932.

The author considers those chronic, painful joints which follow an injury in which there was no evidence of damage to the bone nor to the articular surface. He pays particular attention to the knee, and reports eight cases and, when the condition occurs in the knee, he calls it the syndrome of Pellegrini-Stieda. Classically this syndrome may result from a sprain of the internal or external lateral ligament or from a contusion. After the injury the area remains tender and there is a variable amount of disability which may last indefinitely. In the classical cases new bone appears in the region of the injury (generally the origin of the internal lateral ligament into the femur) and may be palpated or seen in the x-ray. The author believes that the condition is primarily a nerve injury which is followed by a hyperaemia with resorption of bone from the epiphysis and deposition of calcium in the oedematous connective tissue of the capsule. There may or may not be a hematoma and there may or may not be necrosis with connective-tissue proliferation. He believes that the local excess of calcium drawn from the epiphysis as a result of the nerve injury is an important factor and that this leads to calcification and ossification. It is especially common in the shoulder where the calcium is deposited in the subdeltoid bursa. The same condition may occur without the deposition of calcium and the majority of cases are of this type. The condition is differentiated from traumatic arthritis in that the joint surfaces are not involved, although it may be accompanied by traumatic arthritis. The treatment is rest and the author particularly warns against massage which he believes has a tendency to exaggerate the condition. After a period of rest, which is best obtained with an elastic bandage and should be kept up for several weeks if necessary, the author recommends local heat and exercises. Prognosis is good and surgery is rarely indicated. The author recommends blockage of the sympathetic paths to the joint by multiple injections of cocain as advocated by Leriche and thinks that roentgen therapy is strongly indicated in the early cases, but has had no experience with either of the above forms of treatment.—*J. Albert Key, M.D., St. Louis, Missouri.*

BENIGN ANGIOMATOUS TUMORS OF SKELETAL MUSCLES. Hilger P. Jenkins and P. Arthur Delaney. *Surg. Gynec. Obstet.*, LV, 464, Oct., 1932.

The authors present a thorough study of a case of benign angiomatous tumor of the gluteus maximus muscle, and review 256 reported cases, of which sixty-two are summarized.

Ninety-four per cent. of the tumors appear before the age of thirty years; almost half occurred in the first decade. Heredity is not a factor and trauma was present in only seventeen per cent. A congenital factor is possibly of primary importance.

The gross pathology presents three main types: diffuse, circumscribed, or partially circumscribed, the former being the most frequent. The diffuse type often involves other structures than muscles,—as nerves, subcutaneous tissue, periosteum, synovial membrane, large arteries, skin, and large veins.

Microscopically, the most frequent vascular structure was the cavernous space lined by a single layer of endothelium with a thin wall. Arterioles were usually thick-walled with narrow lumen. Thrombi were frequently present. Degenerative changes were advanced in the central part of the tumor.

The most common symptom was a tumor mass, usually slow-growing. Muscles of the extremities were most frequently involved, particularly those of the thigh and leg, though the chest muscles were involved in nearly as many cases. In the large majority of the cases only one muscle was involved. The diagnosis is made on the age of appearance of a slowly developing tumor, the location, pain, some functional impairment or deformity, aspiration of blood and x-ray if phleboliths are present. The differential diagnosis must be made from lipoma, neuroma, fibroma, cold abscess, sarcoma, cysts, and myocytes.

The treatment is local excision. Hemorrhage was a considerable problem in thirty-

eight cases. The prognosis for relief of symptoms is excellent, recurrence in only six per cent. Disability followed in five per cent. No deaths were reported.

Photomicrographs showing the tumor structures are excellent.—*Richard McGovney, M.D., Los Angeles, California.*

UBER MYELOM IM KINDLICHEN ALTAR. (Myeloma During Childhood.) Karl Zäh. *Virchows Arch. f. Path. Anat.*, CCLXXXIII, 310, 1932.

A detailed autopsy report is made of a case of myeloma in a six-year-old boy. The lesions were found in several of the cervical vertebrae, and also in the lungs. Clinically, the course was that of tuberculous spondylitis. Histologically, the condition was a myeloblastic myeloma with occasional masses of erythroblasts. This is the third case on record of typical myeloma in childhood, and the first to be reported in the German literature.

The article contains an extensive bibliography.—*R. J. Dittrich, M.D., Fort Scott, Kansas.*

UEBER DISTORSIONEN DER LENDENWIRBELSÄULE BEI SPORTUNFÄLLEN. (A Consideration of Traumatic Deformities of the Lumbosacral Vertebrae Resulting from Sport.) J. G. Knoflach. *Wiener Klin. Wchnschr.*, XLV, 136, 1932.

Particular significance is attached to injuries of the spine in view of their frequency, resulting from vocational and traffic accidents. The author, however, contributes this article because of three such injuries occurring during participation in sport. Traumatic deformities frequently occasion severe damage to the vertebral medulla, thus causing vocational handicaps and often endangering life. Such injuries are not recognized excepting through numerous and late examinations following accidents, then being evidenced as a post-traumatic spondylitic lesion, such as is found in Kümmell's disease. These lesions commonly are not demonstrable early by x-ray.

If injuries to the lumbosacral region are only contusions, they are relieved in a short time, and the circumscribed evidences of pathology to the soft tissues overlying same are established. Therefore, because of their relatively short period for recovery, further clinical and x-ray examinations may be excluded.

The three cases of such injury to the lumbosacral spine are described in detail by the author, all having been sustained during participation in sport. The findings in all three subjects are identical. Pain, in all, is most severe in the lumbar spine during movements or attempts at motion.

In the three patients presented, the subjective symptoms did not definitely disappear until after three months, and the patients were able to resume their vocations in from three to five months. After one year the three cases disclosed no symptoms, and the x-ray findings were negative. However, during bending and stretching, there was admitted a feeling of uncertainty in the lumbosacral region. Severe injury to the joint and ligamentous structures of the injured vertebrae caused marked functional loss in the lumbosacral region. This was noted through the complete abandon on the part of the patients.

In the three cases there never was established, during the course of the disease or later, positive clinical or roentgenological findings of a specific lesion, for which trauma could be blamed. Nevertheless, they are considered as correct instances of distortion or dislocation of the lumbar vertebrae. The long duration of the symptoms should rule out simple contusion. Furthermore, the similarity of the symptoms in these cases with those described by Kocher, Henle, and others, under the consideration of cervical dislocations, is the cause for the assumption that the cases cited may be considered as traumatic deformities of the lumbosacral vertebrae resulting from sport.

In this article the etiological, x-ray, and diagnostic findings are very thoroughly discussed and the opinions found in the literature are quoted.—*Alfred J. Buka, Pittsburgh, Pennsylvania.*

NOTE: We regret that, on account of lack of space, we are unable to publish in full the excellent abstract of this article as prepared by the reviewer. *Editor*

# The Journal of Bone and Joint Surgery

## THE BACKGROUNDS AND FOREGROUNDS OF ORTHOPAEDICS \*

BY JOEL E. GOLDTHWAIT, M.D., BOSTON, MASSACHUSETTS

The choosing of a subject for such a lecture as this has not been easy but, with the background of nearly forty-five years of practice in our special branch of surgery, with the privilege of acquaintance with many of the great leaders in our work for the generation previous, together with the appreciation of the work as it is being developed today, it seemed not unreasonable to make of this meeting a time of analysis of the real features which led to our existence as a specialty, and which are shaping it for permanence or for ending.

In such an analysis, naturally that which has gone before is important in planning expectations for the future. To predict what is ahead must, of necessity, be attended with uncertainty, but, if the history of the work is carefully studied, the prediction for the future is much more likely to be correct than if it is attempted without such knowledge.

It is essential, if we are to shape our course rightly, that the foundations of our work be known and studied. Knowledge of this sort not only helps us in matters of direction of our efforts, but also saves what would otherwise be much duplication of effort.

In such a study it is natural to turn to the words of the founder of our branch of medicine. In 1741, Dr. Andry, the Councillor to the King of France, the Professor of Medicine in the Royal College, and Senior Dean of the Faculty of Physick at Paris, wrote a book entitled "Orthopaedia: Or, the Art of Correcting and Preventing Deformities in Children".† The title, as the author explains, is made up of two Greek words, meaning straight, or free from deformity, and child. The book then goes on to describe the general structure of the individual with rules for its best possible use. The text is simple, so that it "may be put in Practice by Parents themselves and all such as are employed in Educating Children".

\*The Robert Jones Lecture delivered at the Hospital for Joint Diseases, New York City, October 27, 1932.

†Orthopaedia: Or, the Art of Correcting and Preventing Deformities in Children. Translated from The French of M. Andry. London, A. Millar, 1743.

The book deals with the "correction and prevention of deformities", but in the text that which has to do with prevention uses two-thirds of the book.

In this treatise the author deals first with the structure of the individual and, once this is appreciated, the function to be expected. As for the structure, the author recognizes the fact that all are not made alike, the types of the present day being plainly stated (Book I, page 71):

"The Neck is either long or short, thick or slender.

"The Breast is either broad or narrow, flat or rising.

"The Waist is either thick and clumsy, or slender and delicate; short or long. . . .

"The Legs are either slender or thick, long or short, or of a middle length. Here we must remark that when the Neck is long, the Legs and Ears are long likewise. . . .

"There is not one of those different Conformations, as well of the Head as of the other parts of the Body, that does not bear a necessary proportion to the rest of the parts."

After dealing at some length with the varying structure of the individual, similar in every way to the so called "body types" of our day, the author then goes on to the study of such structure with function as the chief aim. After describing the spine, he states (Book II, page 77): "When the Spine is straight, well set, and finely turned, it makes a handsome Body; and where it is crooked and ill turned, the body is Deformed."

Later, in describing the chest, he states (Book II, page 79): "A high Chest, for Example, provided it is not raised above a certain Point, has a fine Effect upon the Eye. A Chest, on the contrary, that is flat and depressed, looks very disagreeable; besides that this Figure is not so commodious, neither for Health nor long Life."

In order that the body may be developed at its best—and in this he constantly refers to the best for function as being the best aesthetically—he begins with "Caution to Mothers when they swaddle their Infants", so that the shoulders and chest may not be cramped or distorted.

For a later stage of child life, the "Proportion of the Haunches and Belly" is discussed. "The Haunches should be held flat; the Belly should not advance too much forward." As part of the treatment of such conditions, careful attention is given to special chairs and ways of sitting. In this he even recognized the sagging of the abdominal organs and a special chair is suggested to assist with the treatment of this condition.

In this general discussion the selection of the proper shoes receives careful consideration (Book II, page 85). "Shoes that are too high heeled will make the Bodies of Children crooked."

Careful instruction is given for children when sewing or studying that the body may be used rightly.

Also the positions in bed for sleep (Book II, page 86): "Not to let Children sleep upon high Bolsters, or to allow them none at all, is another means for preserving the Bodies of Children straight." This from a

Frenchman, to those who know the national use of the bolster, makes the elimination surprising.

The appreciation of the best that we know of "Body Mechanics" today is indicated in the following (Book II, page 89): "When a Child advances his Belly too much, some imagine the best method is to clap a bit of Lead upon it, or some other Weight; but by this means he is obliged to bend himself backwards." "She (Nature) teaches Parents to take care not to put any Lead upon the Bellies of Children—but, on the contrary, rather to make them wear it behind. This will oblige them to keep in their Belly and at the same time hinder them from bending back."

In speaking of round shoulders, he states (Book II, page 115): "To hinder the Shoulders from growing round, you must take care to keep the Elbows well back, placed over the Haunches and the Chest forward." If one shoulder is higher than the other, he naively suggests (page 119): "Another method still, is to make him carry a little Ladder, made on purpose for that end, so as it may rest upon his Shoulder by one of its Steps. The Shoulder which supports it will rise, and the other will fall lower. These little Ladders may be proportioned to the Age and Body of the Child, and it will be a Pleasure and Diversion for him to carry it."

This latter suggestion would hardly fit in to the present-day order of activity, but it indicates what is suggested throughout, the thoroughness of the study of the child and treating of the special need with reference to the body as a whole.

With Andry, the obtaining or the preservation of the best function of the body, or the special part, was the basic ideal of that which represented orthopaedia. At his time the physician was expected to treat the whole individual, and with reference to the best function; nor did this ideal start with Andry, since, with the very early writing, the same general idea is manifested. A strong, healthy, well poised or well functioning body was the ideal of the early Greeks, as well as other civilizations. Also the correction of deformities had often been attempted before Andry's time. Hippocrates' method of the forcible correction of spinal deformities is probably known to most of you. It was reserved for Andry, however, who not only saw the special need of his work, but who had vision and influence enough, to start a movement with enough momentum so that we, today, nearly two hundred years later, are carrying on under the same colors.

During these nearly two hundred years, the principles of Andry have not always been prominent in the teaching of medicine, but they have never been lost, and from time to time individual observers have contributed something to the general knowledge that has been of help in correcting the existing deformities,—such as Stromeyer's tenotomy, or in better caring for the individual and thus lessening the tendency to deformity.

In fairly recent times such names as Hugh Owen Thomas and Robert Jones, of Great Britain; Alessandro Codivilla, and our contemporary, Vittorio Putti, of Italy; Lewis A. Sayre and C. Fayette Taylor, of New

York; Buckminster Brown and Edward H. Bradford, of Boston, suggest at once the names of men whose sane reasoning, always thinking of the end result with as perfect a functional general result as was possible to obtain, makes them worthy followers of Andry.

Always the idea of the best condition for function has represented a dominant note in all that was represented by Andry's conception and what has grown out of it. As the profession has developed in late years, with the responsibility for the care of the patient so much divided up, in the extreme development of specialism, many times the chief aim is to relieve symptoms with immediate results, without much regard for the careful study of the conditions leading to the best permanent function. During the World War in the care of the bone and joint injuries, with the severe muscle and nerve injuries, it very early became obvious that the general surgeon might be able to perform a more perfect operation than the orthopaedic surgeon who might be available; but, from the point of view of ultimate result, having in mind the usefulness of the part, the conditions were so strikingly reversed, that the responsibility for the care of such cases from the beginning of the injury to the transport home, was transferred, with the wish of the general surgeon, to the orthopaedic surgeon. The type of injury to be treated had rarely ever been seen by the orthopaedist any more than by the general surgeon, but the basic principle of training made the orthopaedic surgeon see from the very beginning an end result, and the special case simply demanded the adaptation of well understood principles to the War casualty. It was this basic training that forced Sir Robert Jones into such a prominent position in Great Britain. Good surgery without proper care before and after operation resulted in too many cripples, and each year Sir Robert was turned to more and more to improve the conditions. The results obtained by him not only established his position for the War need, but have led since to the development of the special hospitals and clinics all over England for carrying on the orthopaedic work of civil life.

This part, or what might be called the "Backgrounds", indicates carefully planned work based upon the special structure of the individual, leading to the best possible general function; deformities corrected, of course, but the prevention of deformities by careful training being the larger and more important part of the work. The special ideal of the work has been the best of which the individual was capable, recognizing that a healthy body was a good looking body. Much of the work that has passed has been fine; the challenge to us present-day workers is to demonstrate our fitness to carry on this work.

#### "FOREGROUNDS"

At this time when the medical profession has moved so far away from that which existed up to two or three decades ago, when the physician was in reality a general physician assuming the entire responsibility for the patient seeking his advice, a new adjustment is necessary. In the earlier

period the doctor was surgeon, as well as physician, meeting all the needs, knowing very little of what is called psychiatry today, but nevertheless practising the best kind of mental health. In special lines of work he was not the equal of the men of today, but no one can have witnessed the scattering of the responsibility for the care of the patient, with the many specialists sharing in it, without being aware that while much of the new is fine, much of the old was also fine. To try to get the best from each and make a still better is the great challenge for us today; and, until this is accomplished, we must expect to find our patients turning more and more to the irregular practitioners.

In our special line of work, with the great interest in the operative side of the work, with the general indifference to the non-operative, or to the operative case once the operation is performed, one can but wonder if the basic ideals which justify our work have not been lost sight of. If we are to see only the operation, leaving the after-care to the slightly trained house staff with the physiotherapy given by an entirely different department, of which we have little control or knowledge, we cease to be true orthopaedic surgeons, but just surgeons doing bone and joint work. If we still further recognize that three-fourths of the patients coming to an orthopaedic clinic are turned over to the junior staff, having little knowledge of the real condition, or too little time to carry out the treatment, the responsibility for which we are supposed to exist is being largely missed.

In many of our large clinics it would be far better to have the "chief" remain in the out-patient department and let the junior staff carry out the operative work. The skill required for this operative work is much less than that required for diagnosis in the many non-operative cases, with the planning of the appropriate treatment. Back cases, as usually seen, are uninteresting, because the average surgeon does not understand them. Once understood, they become interesting, and, intelligently treated, cease to be the burden of the clinic. The same is true with the average arthritic, or the paralytic, or the average foot case, or the average visceral case,—cases which respond so easily if rightly handled as to represent the greatest possible satisfaction to the physician. The indifferent care of most of these cases, in the average clinic, unless they can be called operative, not only is pathetic from the point of view of the patient, but represents a great waste to the hospital. The endless putting on of plaster jackets or braces, of strapping feet or knees, without first correcting the mechanical features that are at fault, is purposeless, and not only means waste of material and time, but, with so little gained, causes discouragement to both patient and physician.

The greatest need today for those of us who call ourselves orthopaedic surgeons, it seems to me, is to train ourselves so that what is involved in the "prevention" part of Andry's work is better understood: with the expectation that the increased knowledge of these two centuries will, if properly used, make it possible to carry the work in this line farther than was possible with Andry, just as is true with the purely operative part.



In such preparation the great need seems to be to carry our studies farther along the two lines emphasized by Andry,—first, the body types or varying anatomical structures, and, secondly, the function to be expected of the body in all its parts once the peculiar structure is known.

Once we realize that no two persons are made alike, the need of careful study of our patients along such lines becomes obvious and—fortunately for simplicity of study—while the individuals vary, there are, nevertheless, definite types which have their counterparts in the anatomy of the lower orders. That the text-book type does exist there can be no question; but since, apparently, this type has become the most perfectly adjusted to life as a biped, it is rarely seen in the doctor's office except as an accident case. Apart from this text-book normal, there are shown to be two main variations. One is slender in build, with a small skeleton, with flexible joints, with small muscles, with a highly organized nervous mechanism. This type, adjusted for quick moving, as well as quick thinking, should weigh as its normal from fifteen to twenty pounds less than the so called normal. Athletically, it is the short-distance runner, the hurdler, pole vaulter, the contortionist, etc.,—the "Uncle Sam" type. This type not only has the motor mechanism, bones, joints, muscles, etc., that are peculiar, but the viscera are different in shape and attachment from those of the text-book type. The stomach is tubular in shape, attached with a loose mesentery, the small intestine has from ten to fifteen feet of length instead of the text-book twenty. The large intestine is considerably shorter than the text-book type and has a much freer mesentery. The liver is small, with loose attachments. The skin is soft, and the hair, which is usually abundant, is usually soft and fine. The body is long in the torso in proportion to the thickness through, the neck and loin being particularly long. The arms and legs are usually long and slender, with feet naturally high-arched, and with hands slender, with long, tapering fingers. The face is commonly narrow, forehead high, and the ears usually large and prominent.

In contrast to this at the other extreme is the stocky or thick-set type with a skeleton heavy, joints relatively inflexible, muscles large, with coarse fibers. This type should weigh from fifteen to twenty pounds more than the text-book normal. Athletically, it is the wrestler, the weight lifter, the long-distance swimmer, etc.,—the "John Bull" type. With this type the bones are large and the joints are made for inflexibility,—the "closely knit" individual. The viscera also have their peculiarities, with the stomach large and pear-shaped, held high under the ribs by its attachments. The small intestine varies from thirty to forty feet in length, in contrast to the text-book twenty, and the large intestine is also considerably longer than the text-book type. The liver is large and heavy and held with firm ligaments well up under the ribs. The skin is coarser, with more connective tissue, and the hair is usually dropped early. The body is relatively short in the torso, is much thicker through than the slender, or the text-book type, and the neck is short and thick. The arms

and legs are heavier, with large, coarse-fibered muscles, with feet broad and low-arched, while the hands are broad, the fingers short, with much less difference between their lengths than in the slender or text-book type. The head is usually relatively small and round, with small, flat ears.

These two types, with the text-book type for the third, are fairly constant, although there is marked overlapping of features; one having a slender general type, may have a less flexible spine than would be expected. The viscera vary: the stomach and small intestine may be of the slender type, while the large intestine is larger and more like the heavy type. And thus we might go on, the essential feature being that there are these variations in the human family, and that, of those coming to us as patients, the large proportion will fall into the slender or stocky group.

Once these peculiarities are appreciated, some of the clinical observations become easier of understanding. An intestine of only ten feet will naturally be less able to absorb all of the food values than one of forty feet,—some justification for the individual easily growing fat, or the one remaining thin.

Also, an individual of twenty pounds heavier than the text-book normal, having a larger body to heat, would have as its normal a higher blood pressure than the slender type, with its smaller and lighter structures; and, in a less striking degree, the body temperature varies.

From the point of view of the general physiology, once one appreciates the different anatomical structures, there should be expected variations. The slender, quick-acting individual should have a more rapidly responsive physiological mechanism than would be required for the slower-moving, heavier type. This being the case, the slender should be expected to be able to liberate the energy more rapidly and is, therefore, the hyperglandular individual. In this type the basal metabolism should be from fifteen to twenty points above the zero as its normal. The slower-moving or stocky type should have as its normal a basal metabolism from fifteen to twenty points below the zero.

With such a study it is apparent that the way the body is used is of the utmost importance regarding its function. If used fully erect, irrespective of the special anatomy, the muscles of the trunk should be in balance, so that there should be no undue strain, and the curves of the spine should be such that the joints are not strained. In this position the head will be held well over the shoulders, with the chin drawn in, thus flattening the cervical spine, and thus tightening the deep cervical fascia, which is the suspensory ligament of the diaphragm. This, together with the proper use of the thoracic muscles, insures a relatively high position of the ribs, with resulting adequate space for the organs of the thorax, as well as adequate space under the ribs below the diaphragm for the abdominal organs. In this position the abdomen should be flat and not sagged, the pelvic inclination being about thirty degrees forward from the perpendicular, so that the weight is received upon the pelvis properly, with no strain of the pelvic joints nor the joints of the low spine to be expected.



FIG. 1

Extreme ptosis of the heart and diaphragm, there being thirteen ribs in this case, with the diaphragm down to the last rib.

In this position the weight is received upon the feet so that the muscles are used in balance with strong, well poised feet to be expected.

In this position, with the upper chest held reasonably high, there is adequate support for the shoulder girdle so that the shoulder position should be good, with the scapulae flat upon the ribs at the back, with the circulation of the hands and arms not impaired, nor the nerve trunks unreasonably crowded or irritated.

If the body is used fully erect, the organs should be in positions similar to the text-book teaching, with the liver well up under the ribs, with the

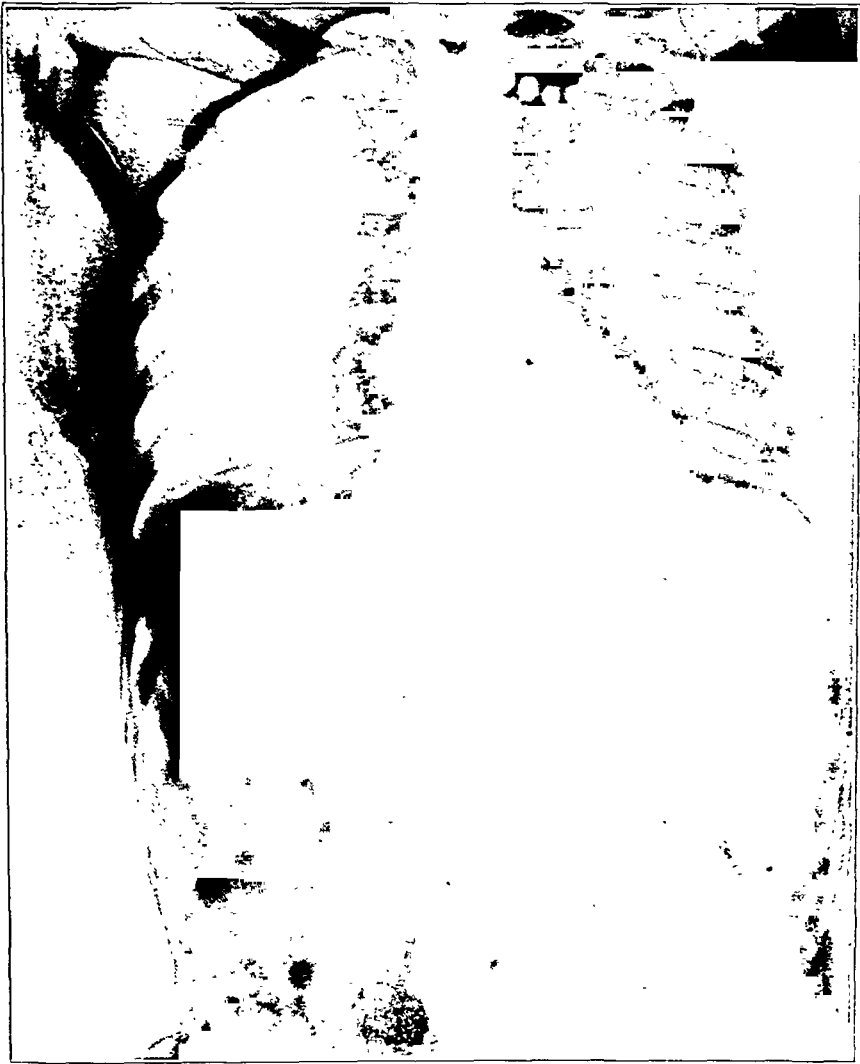


FIG. 2

The so called "text-book" normal, with the diaphragm between the eighth and ninth ribs at the back, the heart beginning at the fourth rib. Abundant space under the diaphragm and lower ribs for the abdominal viscera.

main axis horizontal, with the stomach high, the spleen under the ribs, the kidneys with the upper half resting against the posterior portion of the diaphragm, and with a firm mass of fat filling in the lateral spinal spaces, protecting as well as supporting the kidneys, the adrenal bodies, the pancreas, as well as protecting the splanchnic nerves and the upper abdominal blood vessels. In this position the relations of the stomach to the duodenum are such that drainage is easy, with the circulation unimpaired, so that normal function should be expected, with no tendency to ulcer.

When the body is drooped, however, the conditions are entirely changed,—the pelvis inclines forward more than is normal, the lumbar

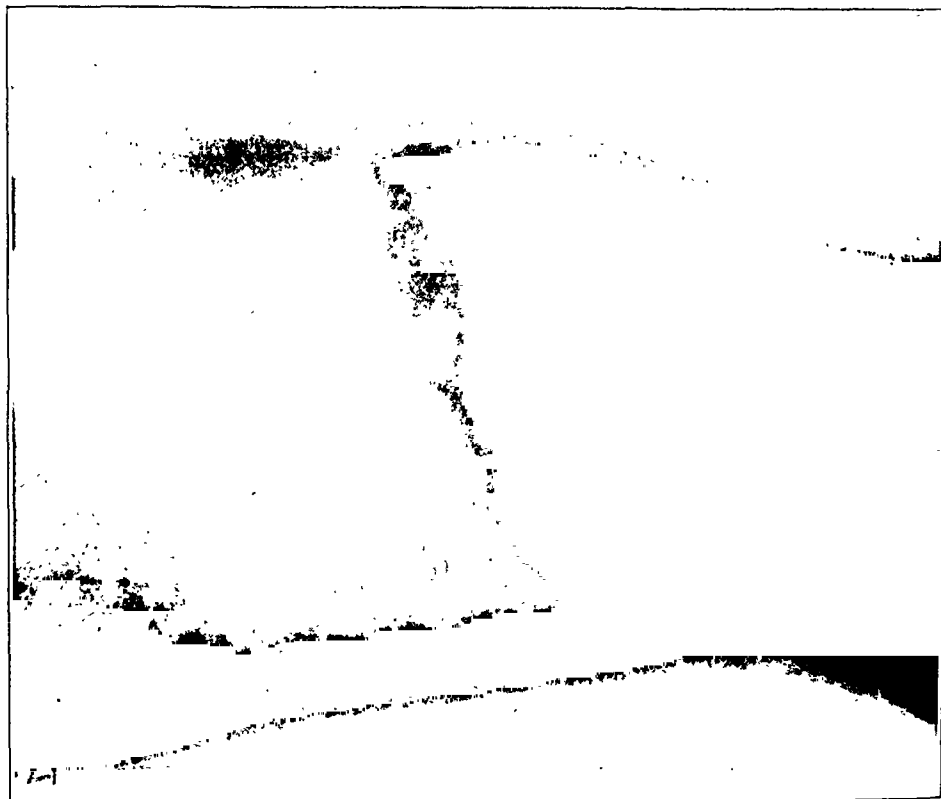


FIG. 4

Normal ideal position of the development with the arch of the diaphragm high, with adequate space in the upper abdomen, under the ribs and diaphragm, for the viscera. Note how shallow the lateral spinal spaces are under such conditions.

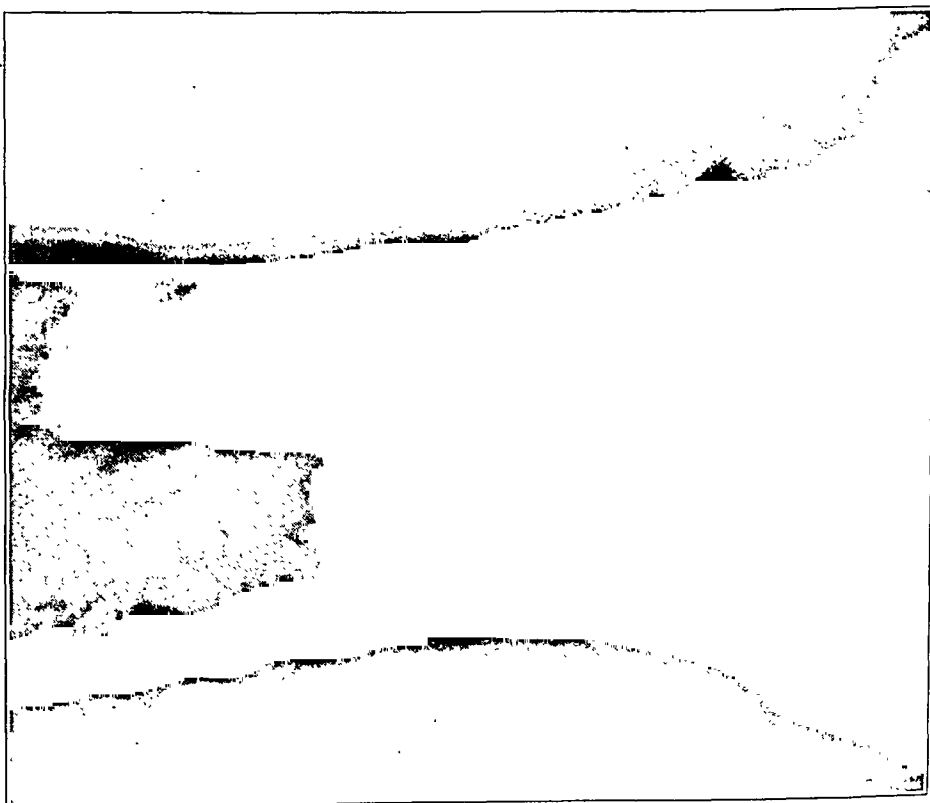


FIG. 3

Extreme ptosis of the heart and diaphragm, with very low position of the ribs, the anteroposterior diameter of the upper abdomen and lower chest much reduced, so that there is practically no room under the ribs and diaphragm for the abdominal viscera, which must, necessarily, be crowded downward, as is indicated here.

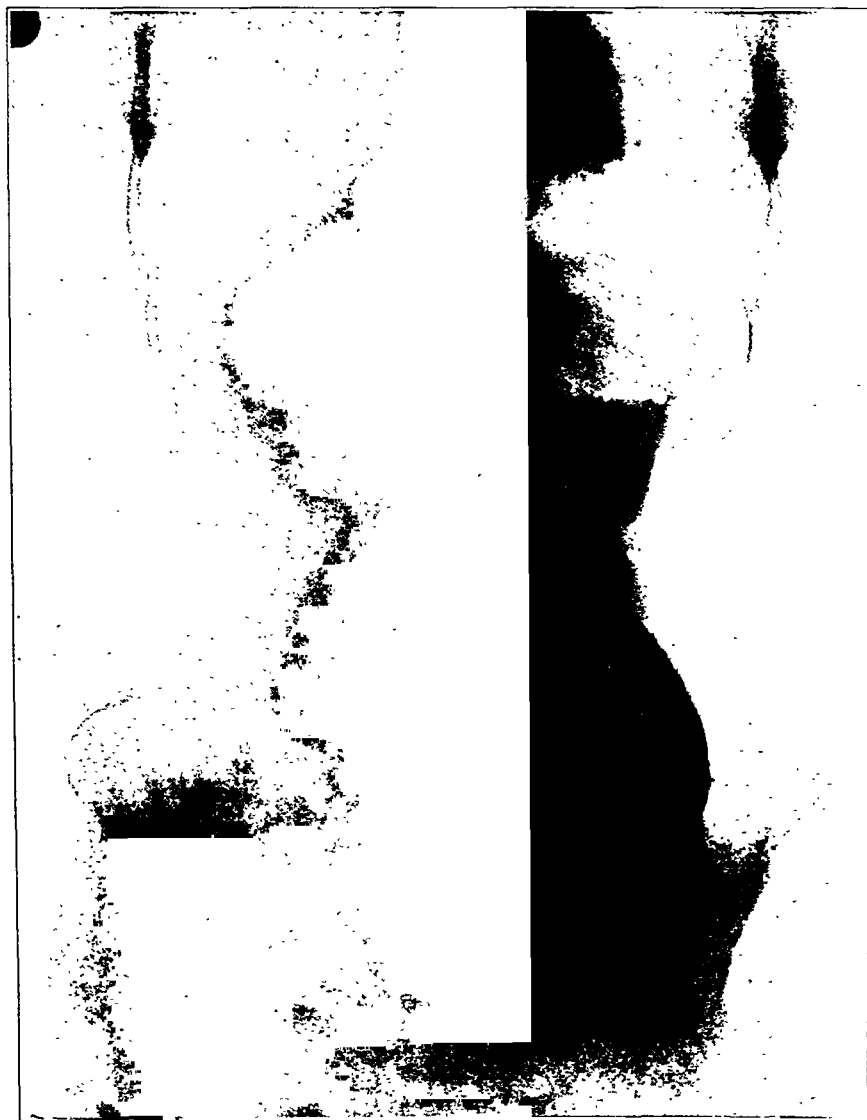


FIG. 5

Extreme ptosis of the abdominal viscera, the diaphragm being down to the last rib, the stomach very low. When such a position of the stomach exists, it must mean a low position of the diaphragm as well. The liver here shows with the axis vertical instead of horizontal. (Retouched.)

spinal curve becomes exaggerated, the dorsal spine is more rounded, the head is carried forward with increase of the cervical curve. The sternum and ribs sag; the abdominal muscles are relaxed; and with this, as well as the low position of the ribs to which the diaphragm is attached, the abdominal organs must be forced downward, while the thoracic organs are dragged downward.

In this position the shoulders are not properly supported upon the

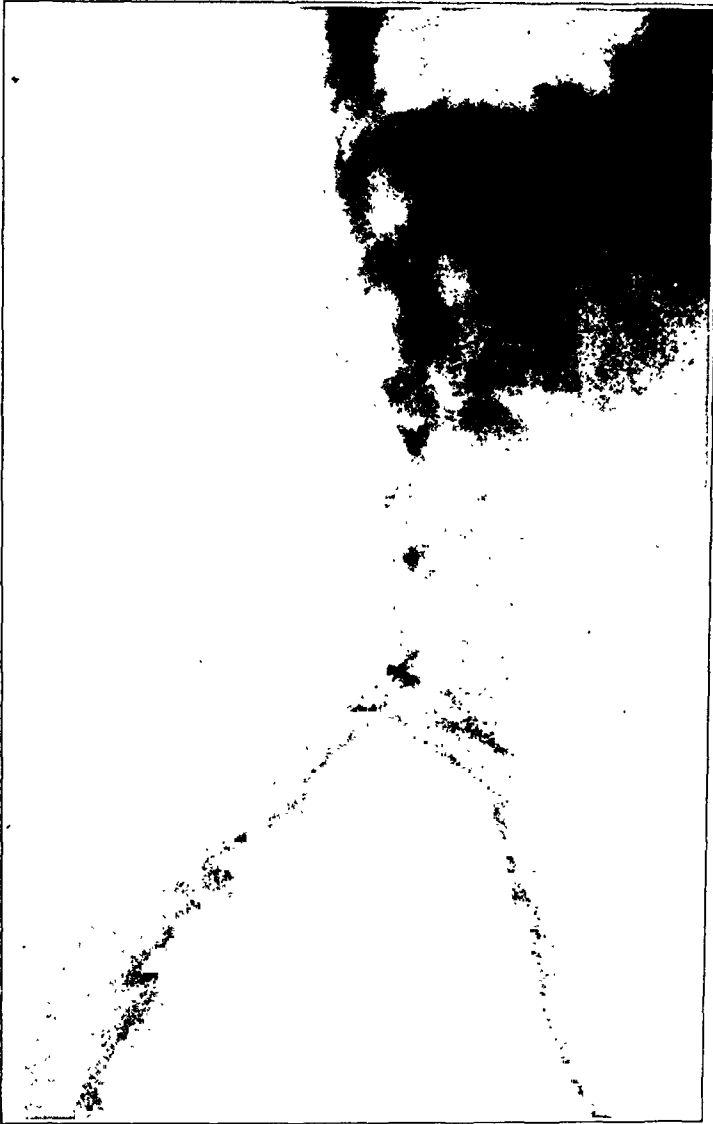


FIG. 6

The relaxed position of the body with the marked forward tip of the pelvis. The thrust of the spine, being received on the top of the sacrum, tends to pull the upper part of the sacrum downward. Note the posterior position of the lower ribs with the resulting increased depth of the lateral spinal spaces.

space under the ribs (Fig. 4) for the liver, and, as it is forced downward, it commonly rotates, the right side dropping down (Fig. 5), so that the main axis is many times vertical instead of the horizontal of the supposed normal. In this position not only is the gall bladder placed with the rounded end downward, but the drag upon the ducts must be a factor in interference with its function. Also in the sag of the liver, with the twist of the organ, the possibilities of harmful drag upon the portal vein or the hepatic vessels must be readily apparent.

With such a position of the diaphragm, the stomach is forced downward (Fig. 5) and the oesophagus is put upon the stretch. If it is the tubular type of stomach, the sag will lead to the J-shaped stomach so

thoracic cage and sag forward and in this position the weight is thrown upon the feet wrongly, with pronated or flat feet the inevitable result, while the same faulty mechanics results in strain or relaxation of the knees.

From the point of view of the general physiology, the degree of sag of the diaphragm is important and is shown in Figure 1, many times dropping to the level of the last rib at the back. In contrast with this is the normal (Fig. 2), with the diaphragm between the eighth and ninth ribs at the back. Under such conditions, and with the lesser sags, the condition is similar only less in degree; the space in the upper abdomen is markedly reduced (Fig. 3). There is no longer a

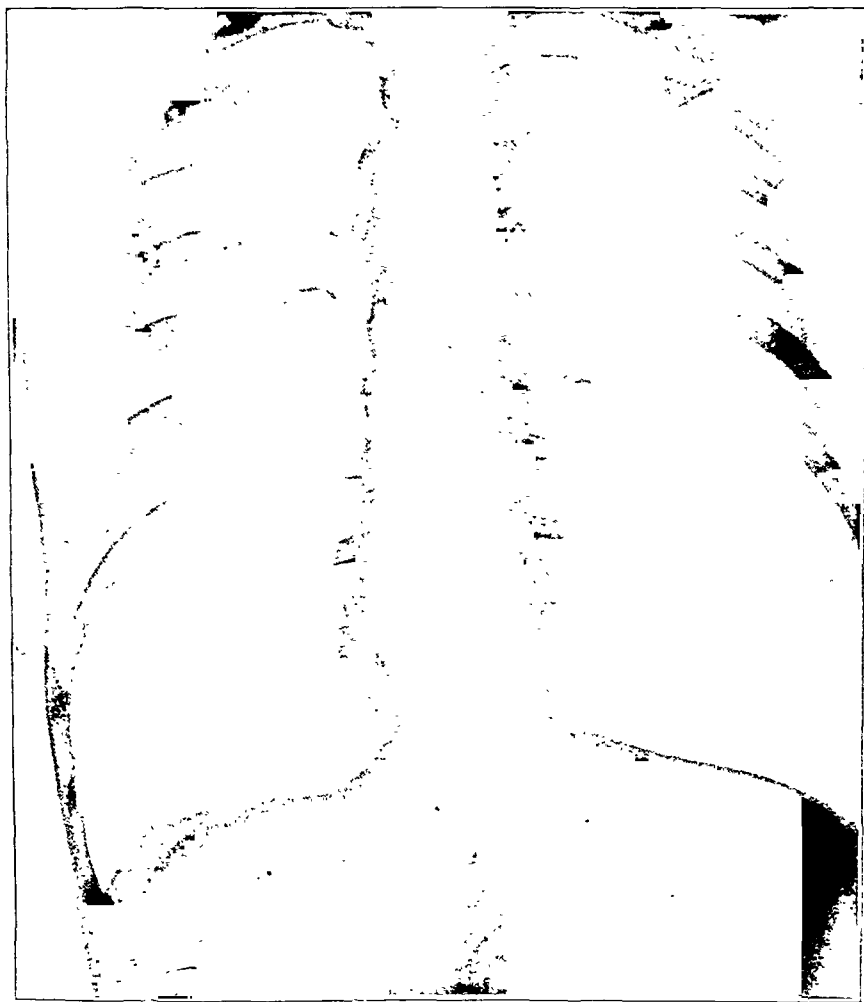


FIG. 7

Extreme ptosis of the heart and diaphragm, the diaphragm at the last rib, the heart vertical in its axis.

commonly seen, but when that is found in the pelvis, or very low, the diaphragm will be down also. With the lowering of the diaphragm, the kidneys, which lie with their upper halves against the lower posterior portion, must be tipped forward and forced downward; the kinks of the ureters are easy to understand, while the possibility of drag upon or interference with the blood vessels serving these organs might offer an easy explanation of many of the kidney symptoms. The orthostatic albuminuria with its quick correction, following the correction of the sagged position, should at least be suggestive of the cause of some of the more serious diseases. With the sag of the diaphragm, the low ribs, which should incline forward and downward, forming a basket-like support for the liver, spleen, stomach, and kidneys, as well as making the lateral



spinal spaces in the upper abdomen relatively shallow, are changed. Under the normal conditions, the pancreas, with its horizontal axis crossing the spine as it does, has the two ends on the two sides well supported, with no unnatural drag upon the middle portion over the spine. With the diaphragm sagged, not only are all of the organs crowded downward more or less, but the ribs drop downward and backward, *not only* losing entirely the basket-like support for the organs but, with the changed posterior position of the ribs (Fig. 6), the lateral spinal spaces are deepened, so that the two ends, the head and tail of the pancreas, must sag backward and produce drag upon the middle portion as it crosses the spine. This, together with the crowding downward of the other organs, is entirely suggestive as a cause of the imperfect function of the pancreas with sugar in the urine, and with the disappearance of the sugar after the correction of the body sag. This is suggestive, at least, of lines of study for the more serious forms of such disease.

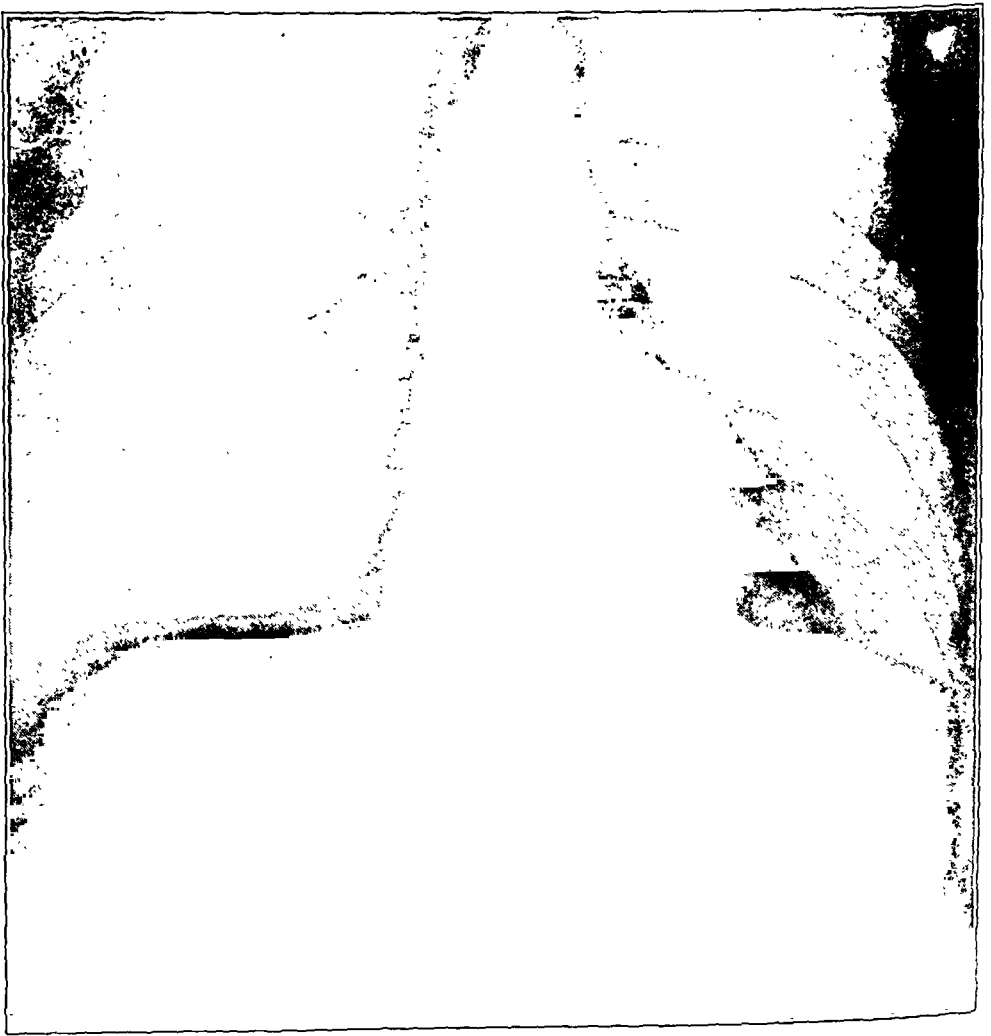


FIG. 8

Extreme ptosis of the heart and diaphragm with necessary ptosis of all the abdominal viscera. Note the heart nearly horizontal in contrast to Fig. 7.

One of the very important of the abdominal blood vessels is the coeliac axis, coming off as it does from the anterior part of the aorta and sending its branches to the liver, stomach, pancreas, and spleen. The beginning of this artery is at the point where the lower portions of the diaphragm arise at the sides of the spine and cross to form the arch under which the aorta passes. With the extreme low position of the diaphragm, this arch of the fibers of the diaphragm must be dragged downward with such possibility of interference with the coeliac axis that it may very well be a factor in the disturbance of the stomach, pancreas, spleen, and liver.

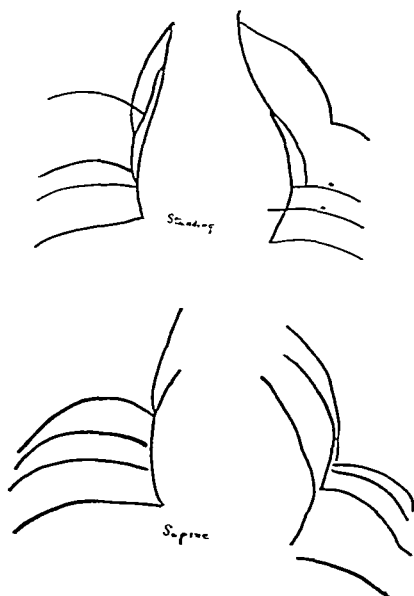


FIG. 9

Fluoroscopic tracings of the diaphragm taken with the patient standing, and lying upon the back. In neutral breathing the excursion of the diaphragm should be about one inch to one and one-half inches, and about midway between full inspiration and full expiration. When lying down the extreme range of motion should be somewhat less.

Under these same conditions of sag the intestines, both small and large, must be crowded downward with natural formation of twists or kinks especially at the hepatic and splenic flexures, and at the same time the abdominal viscera must crowd downward upon the pelvic viscera.

With such a sag of the body, not only must such changes of the abdominal structures occur, but the organs that rest upon the diaphragm will be drawn downward, the heart many times being at least three inches below its so called normal position (Figs. 1, 7, and 8). The arch of the aorta is drawn downward also, and mere demonstrable difference of position makes easy of understanding some of the circulatory disturbances of the head or arms. Under such sag, the blood vessels to these regions must be put upon the stretch.

In that which has been stated regarding the diaphragm, its position only has been mentioned, but its ability to perform its function is of the greatest importance. Some one has called the diaphragm the piston of the human engine and the illustration is not unreasonable, since the movement of the diaphragm, or its rise and fall, is essential to health. Since we realize that in the circulation the heart pumps the blood out but that the diaphragm pumps it back, the ability of both of these organs to perform their function is of the utmost importance. With the heart sagged, as has been shown, one should not expect the vigorous action of the best health, and with the diaphragm sagged, its range of movement or "stroke" must be limited, with resulting general disturbance. Since the diaphragm pumps the blood back to the heart through the compression

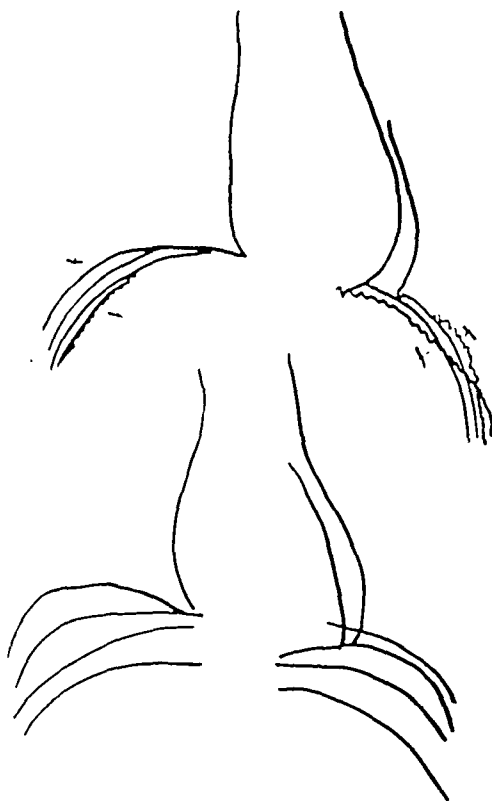


FIG. 10

Tracings as seen in the average case of ptosis of the heart and diaphragm resulting from the poor body mechanics. When standing the excursion of the diaphragm is extremely small, but when lying down the motion is not only freer but about the same on the two sides, indicating that there are no adhesions limiting its action.

standing than in the lying position, and the lines should be generally horizontal, the outer part of the lines being on about the same level as the center.

With the sagging of the diaphragm, not only is the position of both this and the heart low, but the range of motion is less (Fig. 10), the lessening being much more marked in the standing than in the lying positions, unless there are adhesions above or below holding the diaphragm. Not only is the movement shown in the tracing less, but the neutral position is near or on the extreme low point and the sides slope downward well below the level of the central points.

Once the common low position of the diaphragm is recognized, and the limited range of movement is appreciated, the general venous congestion should be expected. Since the diaphragm pumps the blood from the veins to the heart, if it is not working properly, the veins will be full, showing superficially in the hands and also in the legs, where varicosities are common. That which shows so plainly on the surface of the body must occur wherever there are veins, with natural disturbances of the function of the viscera.

of the veins with the inwardly opening valves, if it is not able to perform its function properly, the veins are not emptied and the heart is forced to pump against an increased pressure with, after a time, the weakening of the heart muscle from the overload, similar to the stale muscular condition of the athlete from overexercise.

In the examination of the patients, after the anatomical type has been determined, the next thing is to determine the position of the diaphragm with the heart and the range of motion of the diaphragm. This latter feature is determined by using the fluoroscope, over which tracings on paper are made, showing the up and down position of the diaphragm in ordinary breathing, and also the extreme possible range at full inspiration and expiration. The tracings are taken with the patient both standing and lying (Fig. 9). The ideal tracing should show a range of motion in ordinary breathing of from an inch to an inch and a half, this being about midway between the extremes of inspiration and expiration. With the ideal, the extreme range is more in the

In such a lecture the time does not permit of the analysis of the symptoms referred to the special organs, but, with the appreciation of the faulty position of the organs which can be easily demonstrated, together with the circulatory changes which must result from the equally demonstrable imperfect action of the diaphragm, it should make suggestions at least in explanation of the many symptoms found with the patients.

Naturally, in the examination of the patients, the usual routine should be carried out, with the numerous tests made for whatever value they may possess, but with all this an examination of the patient should be made to determine the special type, as well as to see how the body is used. For this latter, the clothing should be largely removed and the patient examined standing, the examiner noting the general standing position, whether or not the body is erect, whether or not the chest is high and rounded forward, whether or not, in breathing, the circumference of the chest in the neutral or speaking position is midway between full inspiration and expiration. In poor health, with the usual drooped position, the neutral position is near full expiration. In the examination it is also important to estimate the diameters of the chest at the tip of the sternum, the ideal for health being with the anteroposterior diameter about two-thirds of the lateral; to note the circumference of the body at the umbilicus,—this should not be larger than the circumference at the tip of the sternum; to note whether the abdomen is firm and flat in the upper part, as is normal, or relaxed and prominent; at the same time noting the angle formed by the costal cartilages with the tip of the sternum, which for best health should be about ninety degrees.

Care should be taken to note also the position of the pelvis and whether the buttocks are unduly prominent. The hips and low back should be relatively flat, the inclination of the pelvis being about thirty degrees forward from the perpendicular. Naturally, the spine should be noticed, whether or not the curves are reasonable, and especially whether the head is held erect well over the shoulders or protrudes forward. The position of the feet is also important; flat or pronated feet will be more or less certain if the body is drooped.

After the standing position has been checked, the examination should be made lying down, at first upon the back, with not more than one small pillow under the head. In this position, the position of the ribs with the costal angle should be noted, and the low position at the sides should be checked,—in the much sagged body the low ribs often being in contact with the crests of the ilia. With the palpation of the abdomen and upper pelvis, it should be particularly noted whether or not there is much firm fat in the upper lateral spaces of the abdomen. In normal health this region should be firm with much substance between the two hands as palpation from front to back through the loin is made. In the drooped position of the body with the sagged diaphragm, there is usually almost no fat in this region, and with the displacement of the organs there is often

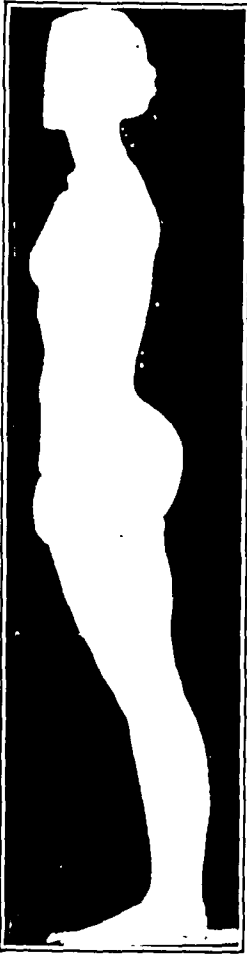


FIG. 11

Silhouette showing an individual with the general poise of the body not bad, but with the base or pelvis of the body tipped forward fully thirty degrees more than is normal, a condition which will inevitably produce weakening of the pelvic joints with natural relaxation of the muscles attached to the pelvis and the general droop shown in Fig. 12.

about, of course, at the same time, giving such other treatment as may be indicated.

This correction of the easily demonstrated faulty mechanics of the physiology should be basic, whatever the special local lesion may be. If an arthritis, whether the common atrophic form or the less common hypertrophic form—since both are in part circulatory

hardly more than the two layers of skin between the two hands. In correcting the condition in order to obtain good health, the treatment has not been completed until this retroperitoneal fat has been replaced with the hard, well developed upper abdomen mentioned.

After checking these features, the patient should be examined in the knee-hand position, noting in this the flexibility of the spine, the position of the low ribs, and how hollow the back is in the loin below the ribs. With proper development there should be no sag of the loin in this position, but when the body is drooped and the retroperitoneal fat is absent, the hollows below the ribs are usually marked.

In this position the abdomen should be palpated, since often in the patient with the low ribs, when lying upon the back, the crowding of the intercostal nerves causes reflex spasm of the abdominal muscles, which usually disappears entirely if the knee-hand position is taken and the ribs sag forward and upward.

After determining in this way the mechanics of the body and after seeing the roentgenograms of the spine with the heart and diaphragm, unless definite evidence of special and well understood disease is found, the rational procedure should be to correct the faulty mechanics of the body, including especially the spine and viscera, and to see what changes nature is able to bring



FIG. 12

Silhouette of a young woman of the same age as shown in Fig. 11, with the resulting relaxation of the pelvic girdle and the natural relaxation of the muscles attached to the pelvis. In this position the patient was standing as well as possible. Note, not only the position of the pelvis, but the relaxed position of the chest, the forward position of the head, and the marked sag of the abdominal viscera.

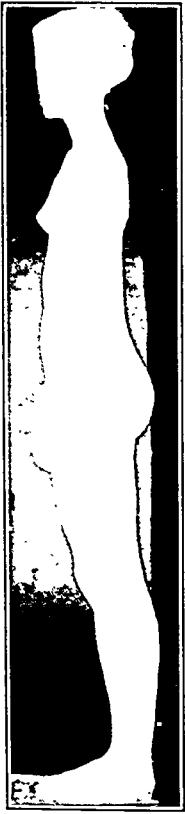


FIG. 13

The position of the pelvis and lower spine are fairly good, but the chest is flat, the ribs low, the head too far forward. The degree of ptosis of the diaphragm in this case will be much less than in Fig. 12, but is an important factor.

and in part nutritive—this should be the first move. In the progressive paralyses, with the apparent passive congestion of the nerve cells, the faulty mechanics should be corrected, and the marked improvement commonly seen makes the real etiology of such cases at least strongly suggestive. If the thyroid is working wrongly, and since in the conditions described there must be congestion of the organ, the correction of the mechanics of the circulation may many times be expected to bring improvement. If the liver, or the stomach, or the pancreas, or the kidneys are not working rightly, and since the low position of the diaphragm must interfere with the circulation of these organs, the correction of the faulty mechanics should be made, at the same time using such diets or other measures as may relieve the special distress of the special organ, but expecting after normal mechanics is achieved that such special diets or other measures will not be necessary. In the same way with the serious anaemias,—with the extreme sag of the diaphragm, there would be congestion of the spleen as well as of the bone marrow, and while liver is indicated for the immediate need, the correction of the faulty mechanics which causes the congestion should be expected in most

cases to relieve the condition and render special diets unnecessary.

In order to intelligently examine the patient and properly direct the treatment, it is important that the physician himself be able to see the faults and estimate their importance.

A few illustrations are shown that should be of help. Figure 11 is a silhouette of a young woman with the posture of the upper part of the body, at first glance, not bad. However, the pelvis, which is the structural base of the body and to which are attached all the trunk muscles, as well as all of the thigh muscles, is inclined forward fully thirty degrees more than normal, with the result that the thrust of the weight of the

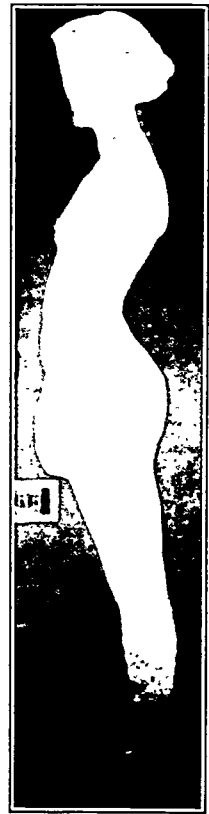


FIG. 14

The extreme general relaxation with forward position of the pelvis, hyper-extended knees, low ribs, forward position of the head, the typical position associated with functional glycosuria, orthostatic albuminuria, dysmenorrhea, poor digestion, etc.

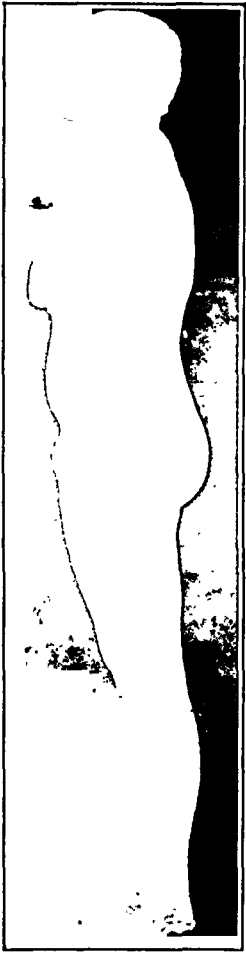


FIG. 15

An individual of the stocky type, the extension of the body in this type occurring at the dorso-lumbar level instead of at the lumbo-sacral level.

Figure 14 shows the general relaxed body with the pelvis and the lumbar spine too far forward, with the ribs very low, with the head protruding forward, and with the natural relaxation of the abdominal wall. Of course, in this type of case, the feet should be pronated or flat, and the knees sprung. It is this type in which one so commonly sees the orthostatic albuminuria, the functional glycosurias, the cystic gall bladder, and the general poor digestion, with much backache and leg ache.

These indicate a few of the types of posture as seen in the slender type of individual, the one most common today.

With the heavier built individual, the droop is always less in amount and the sag of the low back occurs, not at the pelvis and lumbosacral region, but in the upper lumbar and low dorsal region (Fig. 15). In

spine must tend to drag the top of the sacrum downward and forward, strain of the sacro-iliac joints being an inevitable result. It is evident, because of the general poise, that the muscles in this case have not as yet given way, but they inevitably will and with it not only will the pelvic joints be strained but the ribs will be lowered, the head will come forward, and the trunk muscles as a whole will be relaxed, with a definite ptosis of the abdominal, thoracic, and pelvic viscera. Figure 12 shows the figure of a young woman of the same age, whose muscles have given out, with the results as stated above, and with the physiology as a whole disturbed. In both of these cases the individual stood as nearly fully erect as possible. In both the pelvis is tipped too far forward and this must be corrected before real improvement is possible.

In Figure 13 the base, the pelvis, and low spine are fairly well balanced but the chest is too flat, with resulting lowering of the diaphragm. The essential feature in the treatment of this case is to raise the chest, with the drawing backward of the head, in order to pull up the central portion of the diaphragm.

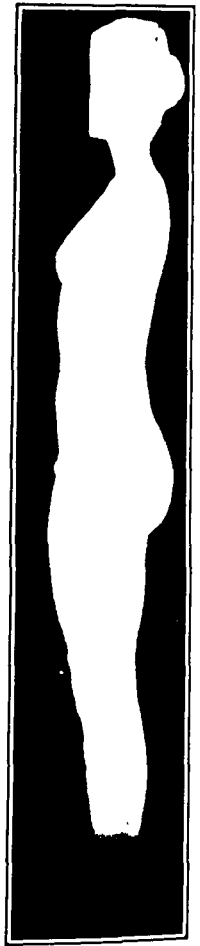


FIG. 16

An individual of the slender type with the body well poised, the muscles in balance, with adequate space in the upper abdomen for the different viscera, and with the diaphragm naturally high. Good health to be expected.

these cases the degree of sag is less, but, since the viscera are held more firmly in place by their ligaments than is true of the slender individual, the compression of the viscera may be more, with more serious disturbances many times the result. It is under such conditions that the cardiorenal diseases of middle life are so often seen. In this type of case the abdomen becomes heavy, but the degree of sag is less than in the slender type, except after long standing, in which cases the abdominal muscles are practically paralyzed, due to the crowding of the thoracic nerves, with the sagging of the ribs, and the twist of the head of the ribs at the costospinal joints.

Once these features are appreciated, it becomes simple for the physician to direct the treatment, with the well poised individual as the desire. Figure 16 shows the slender type well poised, and Figure 17 the intermediate type, also well poised, with the muscles all used in balance, with adequate space for all of the organs, and with the development of the upper abdomen satisfactory. Under such conditions no back nor foot strain should be expected.

Once these features are appreciated, the working out of the details of treatment can be left more or less to the individual physician; but under no conditions should the cases be simply turned over to a gymnast, who usually gives exercises which have muscle building for their aim. The aim in these cases should be to get the muscles in balance, so that proper tone will develop, and the physician should either give the exercises or indicate to the gymnast those which should be used.

For such work, it is important to have the body horizontal more than is usual while the muscles are regaining their tone. There should be from nine to ten hours in bed at night, with no pillow, or only a small one, used, the best position for sleeping, for the slender type, being upon the face, abdomen, or side. Beside this the horizontal position, flat on the back with the arms raised and hands under the head, should be taken for five or ten minutes several times daily. This, of course, tends to flatten the low back and to tip the pelvis backward, as well as to draw the head backward, and, by raising the arms and pulling upon the pectoral muscles, to spread the ribs and broaden the lower chest and upper abdomen.

In the beginning, if the faulty positions are extreme, such as the marked forward position of the pelvis, the horizontal position of the body should be used more, and, when lying upon the back, a large pillow should be placed under the knees to relax the hamstring muscles. If the ribs are

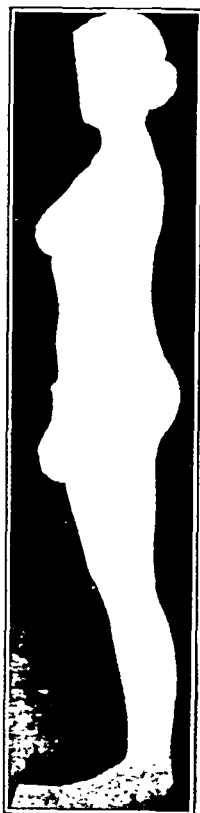


FIG. 17

An individual of the intermediate or "text-book" type also with the body in excellent position for the mechanics of function.



particularly low after the lumbar spine is flattened, a small pillow can be placed under the mid-dorsal spine when the special stretching positions are taken. At these times no pillows should be placed under the head, since it is desired to let the head sag backward and thus help to pull up the diaphragm and low ribs.

During these times of lying down, the exercises for developing the control of the abdominal and buttock muscles should be started. The lower abdomen should be drawn in and held while natural breathing is going on. Also the buttock muscles should be tightened with the attempt to draw, or roll the hips downward, this naturally helping to flatten the lumbar spine so that it will, ultimately, rest properly upon the body of the sacrum. After this has been acquired, exercises for drawing up the ribs should be given, first upon one side and then the other, partly to educate the lateral abdominal muscles, but also to spread the costal angle and raise the ribs laterally, and develop space ultimately for the viscera.

After control of these muscles has been acquired with the body recumbent, similar exercises should be given with the patient standing. During these exercises the patient should have in mind the attempt to draw in the lower abdomen, to draw down the hips, to raise the chest up and forward, and to stand as tall as possible. Once the ability to take the desired position is acquired, walking should be practised, the position of the body being held rigidly at first, but gradually relaxed until the easily well balanced position is natural.

At times, if the condition is marked, recovery is hastened by the temporary use of apparatus to relieve the muscle and ligamentous strain until these structures have been properly developed. Such apparatus does not mean putting on the common special corset, which simply compresses the parts, or braces, which fit the body as it is, but must tend to help in the improvement of the general poise of the body with the ultimate development of the supporting muscles and ligaments. Such apparatus should be used only until the desired muscle balance and tone have been reached.

In all of the treatment careful attention should be given to the natural habits of the patient, to see that in sitting and stooping, as well as standing, the body or torso is held without unreasonable bending at the waist line. Much "buckling" at this region makes impossible the proper development of the upper abdomen with the organs in place.

Naturally, while such general reconstruction is going on, the general condition must be watched, the rapidity of the recovery or the amount of exercise depending partly upon the frequently checked blood pressure and temperature, while symptoms indicating disturbance of special organs should, of course, be given proper attention.

With such an understanding, one would hardly think of fusing the low spine or pelvic joints without first correcting the faulty mechanics, since the faulty position of the parts leading to the strain means also, of necessity, faulty general mechanics, with imperfect weight-bearing on

feet and with imperfect position and function of the viscera. Also, one would hardly expect to correct a flat or weak foot without correcting the general poise of the body so that the foot muscles can work properly. Also, one would hardly expect to arrest and improve the common case of arthritis without first correcting the faulty adjustment of the viscera. Also, one would hardly see the need of a shelf operation for an old congenital dislocation of the hip without first correcting the marked forward tip of the pelvis which places the head of the femur much farther back than need be, especially since the disability of later years in such cases is not of the hip but of the back, because of the extreme lordosis. Also, in the intracapsular fractures at the hip, one should not expect the results to improve materially, irrespective of the local treatment, unless the structure of the bones is appreciated as part of the general disturbed physiology. Bone repair depends upon healthy tissues which the easily demonstrated atrophied bones do not represent. General treatment in these cases is of as much, if not more, importance than the local.

With such an understanding of the anatomy and of the mechanics of the physiology, many cases now not being relieved will become interesting, as well as yielding results that will be satisfactory, while many of the chronic cases now considered hopeless will yield a degree of satisfaction that will make our profession seem quite worth while.

In closing, let me urge you, in the treatment of your cases, to do all that general medicine indicates; but beside that to see that the "body mechanics" are such as to make health possible. Common sense tells one that this can do no harm, since the right use of a machine must be the desirable way; and many times with the human machine the right use gives nature all that she needs to give health.

The need of such work must be obvious and whether we, as orthopaedic surgeons are to do it, as Andry's teaching would seem to indicate, is for us to decide. The opportunity is great and, if we choose the operative work only, which is the easier, instead of the harder and more general, some other specialty or school will take this over. Our basic training should make us better prepared for this than any of the other groups, but of late, certainly, our vision has been so restricted that much of the large problem has been missed. If that which is here presented has helped you in getting the broad significance of orthopaedics, I am glad, and feel sure that something new in the way of satisfaction in your work will be yours.

# THE INFLUENCE OF PERIOSTEUM ON THE SURVIVAL OF BONE GRAFTS\*

BY KEENE O. HALDEMAN, M.D., SAN FRANCISCO, CALIFORNIA

*Department of Surgery, Division of Orthopaedic Surgery, of the University of California Medical School*

The controversy regarding the mode of repair of bone had, as its natural sequel, the dispute as to the survival and growth of the various types of bone grafts. Since Duhamel<sup>1</sup> first advanced the periosteal theory of bone repair two hundred years ago, this explanation has had many ardent supporters, the best known being Ollier<sup>2</sup>. Equally confident, though fewer in number, have been the proponents of the theory that bone is formed by the cell of the cortex. Macewen<sup>3</sup>, in 1912, was one of the first to take issue with the conclusions drawn by Ollier. A third and very different hypothesis has gained ground in recent years. Bancroft<sup>4</sup>, in this country, and Leriche and Policard<sup>5</sup>, in France, have developed the idea that new bone following a fracture is formed extracellularly by the deposition of calcium salts in an oedematous embryonic type of connective tissue. The various theories of bone repair have been shown by diagram in a recent paper by the writer<sup>6</sup>.

Whether or not a bone graft continues to live, and the parts played by its various components in the survival of the graft, is of great importance in the surgery of bones. Ollier believed that a piece of living periosteum-covered bone continued to live and grow after its transplantation to a bony bed. Barth<sup>7</sup>, in 1894, took the contrasting view that all parts of a transplanted bone died and were replaced by a new growth of bone from the site in which the transplant was placed. His conclusion, which was generally accepted during the following decade, was that all varieties of bone material were equally successful. Therefore surgeons turned from living bone grafts to the implantation of dead bone. The accumulation of clinical results during this decade demonstrated the superiority of living over dead grafts.

Axhausen<sup>8</sup>, on the basis of numerous experiments, concluded that, although the greater part of a graft died, its periosteum survived, produced new bone, and established a vascular connection between the transplant and its bed. Macewen believed that the replacement of the dead portions of a graft was accomplished by the proliferation of osteoblasts from the graft itself. More recently, Phemister<sup>9</sup> and others have shown that the dead portions of a graft are transformed into living bone by the process of "creeping substitution" in which the periosteum, endosteum, and cells of the haversian canals of the graft all play a part. This process is doubt-

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TYPES OF BONE GRAFTS				
Advocated on Basis of Clinical Experience or Experimental Work				
Cortex & Periosteum may include endost.	Cortex & Endosteum	Osteo- periosteal	Periosteum only	Miscellaneous Types of Graft
Axhausen (exper.)	Brown & Brown (exper.)	Delageniere (clin.)	Berg & Thalhimer (exper.)	Brooks 2 stage graft (clin.)
Berg & Thalhimer (exper.)	Cohn & Mann (exper.)	Dorrance (clin. & exp.)	Burman & Umansky (exper.)	Klinkerfuss callus graft (exper.)
Brooks (exper.)	Gallie & Robertson (clin.)	Ollier (clin. & exp.)	Mock (clin.)	Markelow heterogenous (clin.)
Davis & Hunnicutt (exper.)	Macewen (exper.)			Straub epiphysis (clin.)
Haas (exper.)	McWilliams 1921 (clin.)			
Hey Groves (clin.)	Speed (clin.)			
Jessen (clin.)				
Kartaschew (exper.)				
Leriche & Policard (clin.)				
Lexer (clin.)				
Mayer & Wehner (exper.)				
McWilliams 1914 (exper.)				
Phemister (exper.)				
Wereschinski (exper.)				

TABLE I

less aided by the ingrowth of bone from the bed in which the graft is placed.

As the survival of a transplant depends upon the inclusion of elements having the power of independent growth, the type of transplant employed by a given surgeon will be influenced largely by his views regarding the osteogenic properties of bone. The foundation for the transplantation of bone was laid by Ollier<sup>2</sup> in 1867, whose results are reported in two volumes, one having to do with experimental and the other with clinical observations. Much experimental and clinical evidence has accumulated since his time. The various methods of bone transplantation, their advocates, and the basis for such advocacy are shown in the table. Doubtless this represents but a small fraction of the papers published on the subject of bone grafts, but it includes the majority of those based on experimental work or extensive clinical analysis. For further information regarding the history of bone grafting, the articles by Hey Groves<sup>10</sup>, Keith<sup>11</sup>, Berg and Thalhimer<sup>12</sup>, and Burman and Umansky<sup>13</sup> are suggested. A most thorough analysis of the results obtained clinically in 1390 cases of various types of bone grafts was made by McWilliams in 1921<sup>14</sup>. The experi-

ments to be reported below were designed to trace the fate of the different types of bone grafts under conditions resembling those found clinically, in the hope that conclusions might be drawn regarding the relative importance of periosteum, cortex, and endosteum to the success of the graft.

#### METHODS

Bone-graft operations were performed on twenty-two rabbits, the ages of which ranged between four and eight months. The method consisted of the production of a defect in each radius and the bridging of this gap by a graft taken from the tibia or fibula of the same rabbit. The ends of the graft were fixed in the open ends of the radius as an intramedullary graft. As two bone-graft operations were performed on each rabbit, it was possible to compare the various types of transplants under the same conditions. Anaesthesia was produced by the intraperitoneal injection of sodium amytal (0.060 grams per kilogram of body weight). The operations, which were done with aseptic technique, were followed by normal healing without any infections. No splints were necessary as the intact ulna prevented undue movement. X-ray pictures of both forelegs were taken at weekly intervals following the operation, until the fate of the grafts became apparent. The animal was then killed and microscopic studies were made of the radius and graft. In certain cases, animals were sacrificed after three or four weeks to show the earlier changes occurring around the grafts. Protocols of the experiments will follow, being more complete in those cases which are used for illustrations. The experiments fall into four groups.

#### PROTOCOLS

*A. Grafts of whole fibula with periosteum, compared to whole fibula without periosteum or split fibula:*

**EXPERIMENT 25.** A segment five-tenths of one centimeter long, including all the layers of the diaphysis, was removed from the middle portion of each radius. A section of the right fibula was excised and divided into two pieces, each one centimeter in length. One piece with its adherent periosteum was placed in the gap in the right radius as an intramedullary graft, while the other piece of fibula was freed from all periosteum and was used to bridge the gap in the left radius. The animal was killed 136 days after the operation, and microscopic sections were made at the sites of the bone grafts. The results of all experiments will be described later in the paper.

**EXPERIMENT 26.** Similar defects were produced in each radius and were bridged with pieces of the fibula. The graft on the right included the entire circumference of the fibula with periosteum, while that on the left consisted of a split piece of fibula with a small amount of periosteum. The animal was killed after 136 days.

**EXPERIMENT 24** was similar to Experiment 25, the duration being 117 days.

**EXPERIMENT 47** was carried out in the same manner as Experiment 26, but the animal died seven days after the operation.

**EXPERIMENT 65** followed the same procedure as Experiment 25, and lasted ninety-one days.

**EXPERIMENT 66** also resembled Experiment 25. The animal was killed after forty-four days.

### B. Grafts of periosteum alone, compared to cortex alone or with endosteum.

EXPERIMENT 64. Following the removal of a segment, four-tenths of one centimeter in length, from each radius, a strip composed of the fibrous and cellular layers of the periosteum was dissected from the right tibia without including any visible pieces of cortex. This periosteal graft was anchored across the gap in the right radius by inserting one end of the strip into each fragment of the radius. A piece of cortex without periosteum or endosteum was removed from the right tibia and inserted across the gap in the left radius. The animal was killed fifty-eight days after the operation.

EXPERIMENT 79, lasting forty-six days, was performed in a manner similar to the preceding experiment except that the periosteum was removed from each radius for a distance of five-tenths of one centimeter from the defect. In this case the graft to the left radius included endosteum as well as cortex.

EXPERIMENT 80 resembled Experiment 79 and had a duration of forty-nine days.

EXPERIMENT 88 was identical with Experiment 64 except that the periosteum was removed from each radius for a distance of five-tenths of one centimeter from the defect. The animal was killed after twenty-eight days.

EXPERIMENT 90 resembled Experiment 79 and lasted thirty days.

### C. Osteoperiosteal grafts compared to grafts of cortex alone or with endosteum.

EXPERIMENT 60. A segment, four-tenths of one centimeter in length, was removed from each radius. An osteoperiosteal graft consisting of two spicules of cortex with considerable adherent periosteum was taken from the right tibia and was placed across the gap in the right radius. A graft consisting of cortex and endosteum, but no periosteum, from the right tibia was used to bridge the gap in the left radius. The animal was killed seventy-four days after the operation.

EXPERIMENT 61 resembled the preceding experiment, but the animal was killed four days after the operation as it appeared moribund.

EXPERIMENT 68 was performed in the same manner as Experiment 60 and lasted forty-six days.

### D. Grafts consisting of cortex and periosteum compared to those of cortex alone or with endosteum.

EXPERIMENT 62. Following the removal of the usual segment from each radius, a graft of cortex and periosteum from the right tibia was placed in the gap in the right radius. The gap in the left radius was bridged by means of a piece of cortex and endosteum from the tibia. The animal was killed fifty-two days after this operation.

EXPERIMENT 63. A piece of cortex alone from the right tibia was placed across the gap in the right radius, while the gap in the left radius was bridged with a tibial graft of cortex and periosteum. The duration of this experiment was seventy-two days.

EXPERIMENT 67. The gap in the right radius was bridged with a piece of its excised segment which had been denuded of periosteum but included the endosteum. This graft was placed with its endosteal surface facing away from the ulna. A piece of whole fibula, including periosteum, was placed across the gap in the left radius. The animal was killed after thirty days.

EXPERIMENT 69. The usual defects were produced in each radius and the periosteum was removed from the ends of the radius adjoining these defects. A piece of cortex and periosteum from the tibia was inserted across the gap in the right radius, and another graft of cortex and endosteum was used to bridge the gap in the left radius. The animal was killed forty-four days later.

EXPERIMENT 87 was performed in the same manner as Experiment 69, but was terminated twenty-three days after the operation in order to observe the earlier changes which take place in grafts.

EXPERIMENT 53 resembled Experiment 62 and had a duration of fifty-one days.

EXPERIMENT 70 was performed in the same manner as Experiment 69 and lasted sixty-three days.

EXPERIMENT 86 also resembled Experiment 69, with a duration of twenty-four days.

### RESULTS

In describing the results of these experiments the same grouping and order will be followed as was used in the protocols.

A. Experiment 25 has been chosen as an example of a fibular graft. A series of postoperative x-ray pictures (Fig. 1) shows that the defect in the right radius, containing a periosteum-covered graft, became completely filled with new bone after forty-two days. The left radius, with a graft denuded of periosteum, showed a delayed and incomplete filling of the defect. Both grafts were represented by faint shadows in the roentgenograms after 136 days. In photomicrographs of the two specimens (Fig. 2) the graft in the right radius is seen to have survived as living bone which has united with the radius. No trace of the graft appears in the section taken through the left radius.

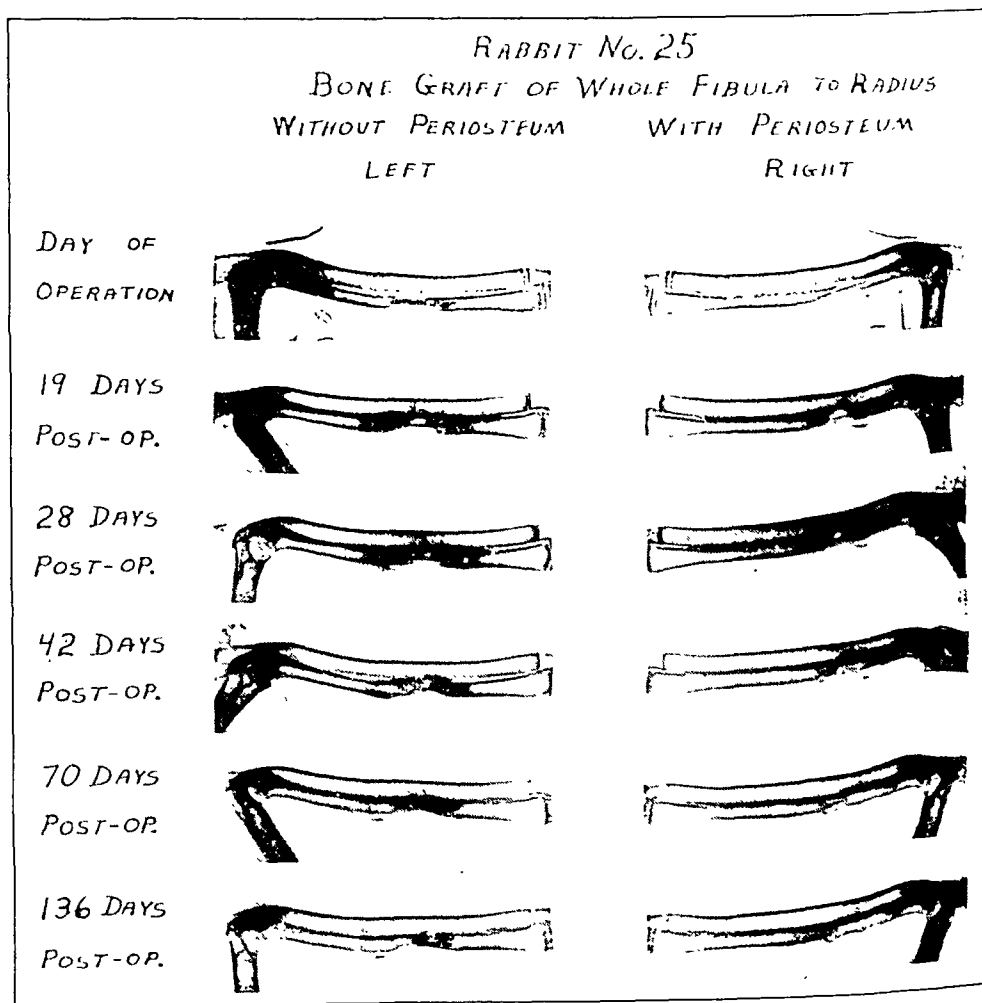


FIG. 1

Experiment 25. Roentgenograms.

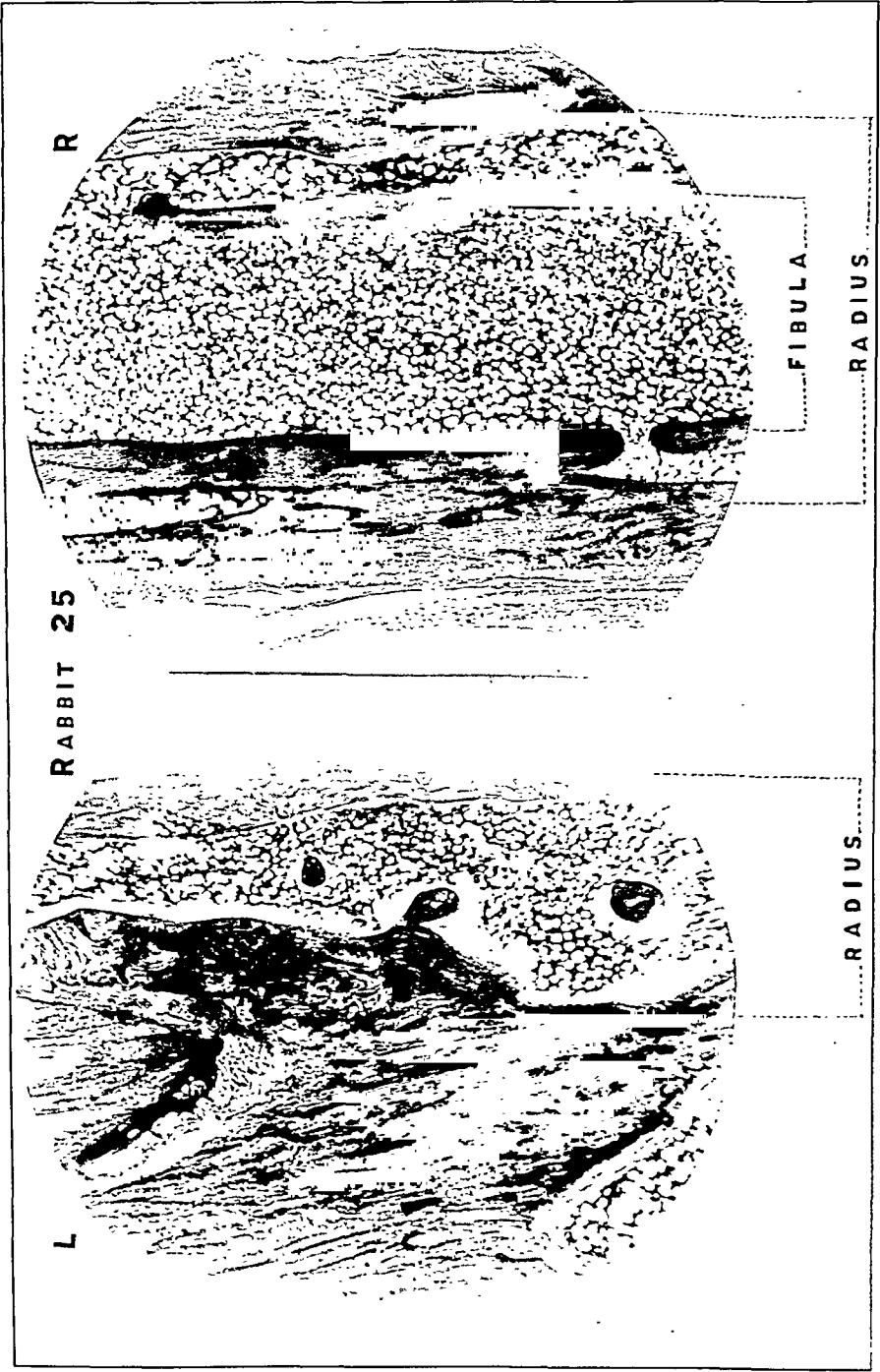


FIG. 2  
Experiment 25. Photomicrographs.



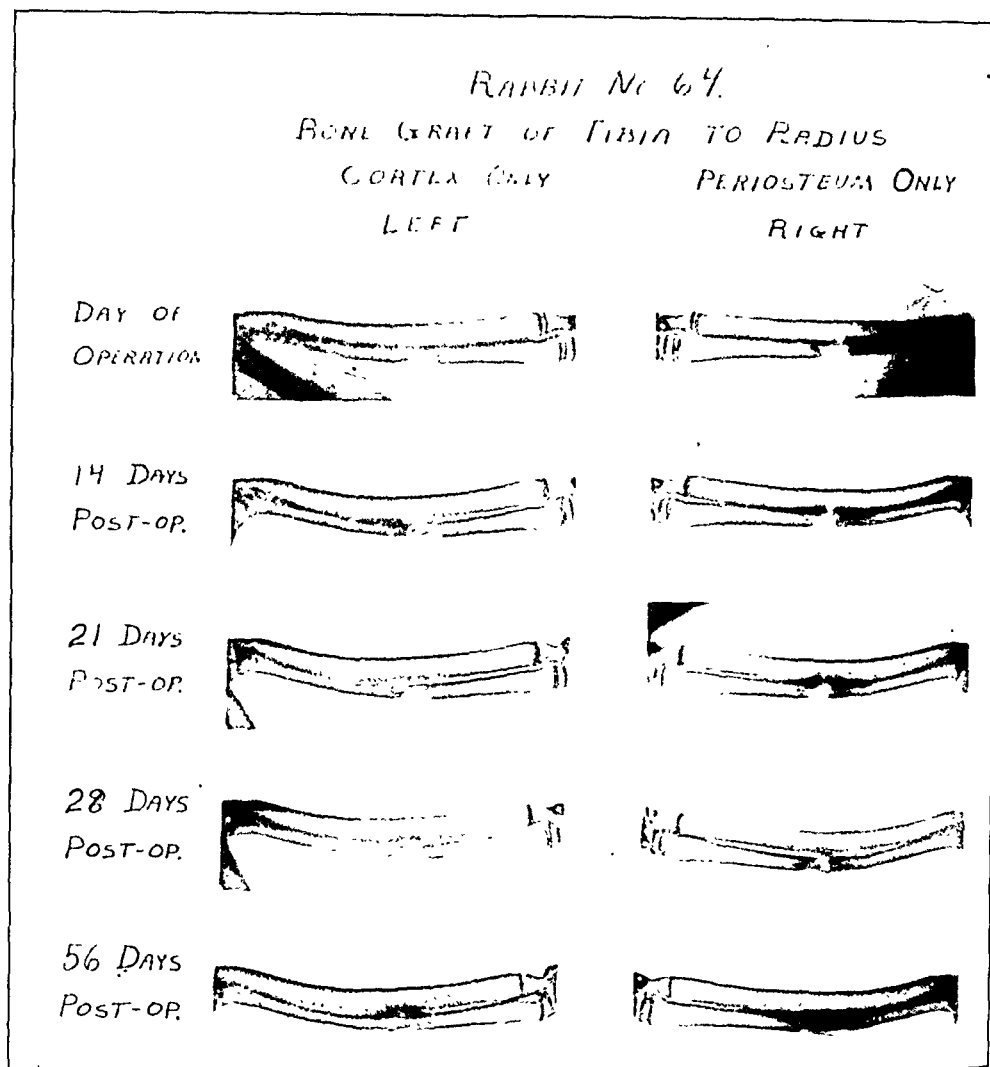


FIG. 3

Experiment 64. Roentgenograms.

In the case of Rabbit 26 there was a more rapid and complete closure of the defect in the right radius, which contained a segment of the whole fibula with its periosteum. The left radius contained a split piece of fibula which had less periosteum than would be included in the whole piece. On this side the closure of the defect was incomplete. In Experiments 65 and 66 the presence of periosteum on the graft apparently favored the survival of the graft and an early closure of the defect. The two other cases in this group gave inconclusive results. In Experiment 24 both bones of the left foreleg became fractured, and all fractures united in the same time. Rabbit 47 died seven days after the operation, before any callus could be demonstrated.

B. Experiment 64 is a representative of the group in which the periosteal graft is compared to the graft consisting of cortex alone. From x-ray pictures (Fig. 3) it is seen that the periosteal graft has completely filled the defect with new bone in twenty-eight days, while closure of the

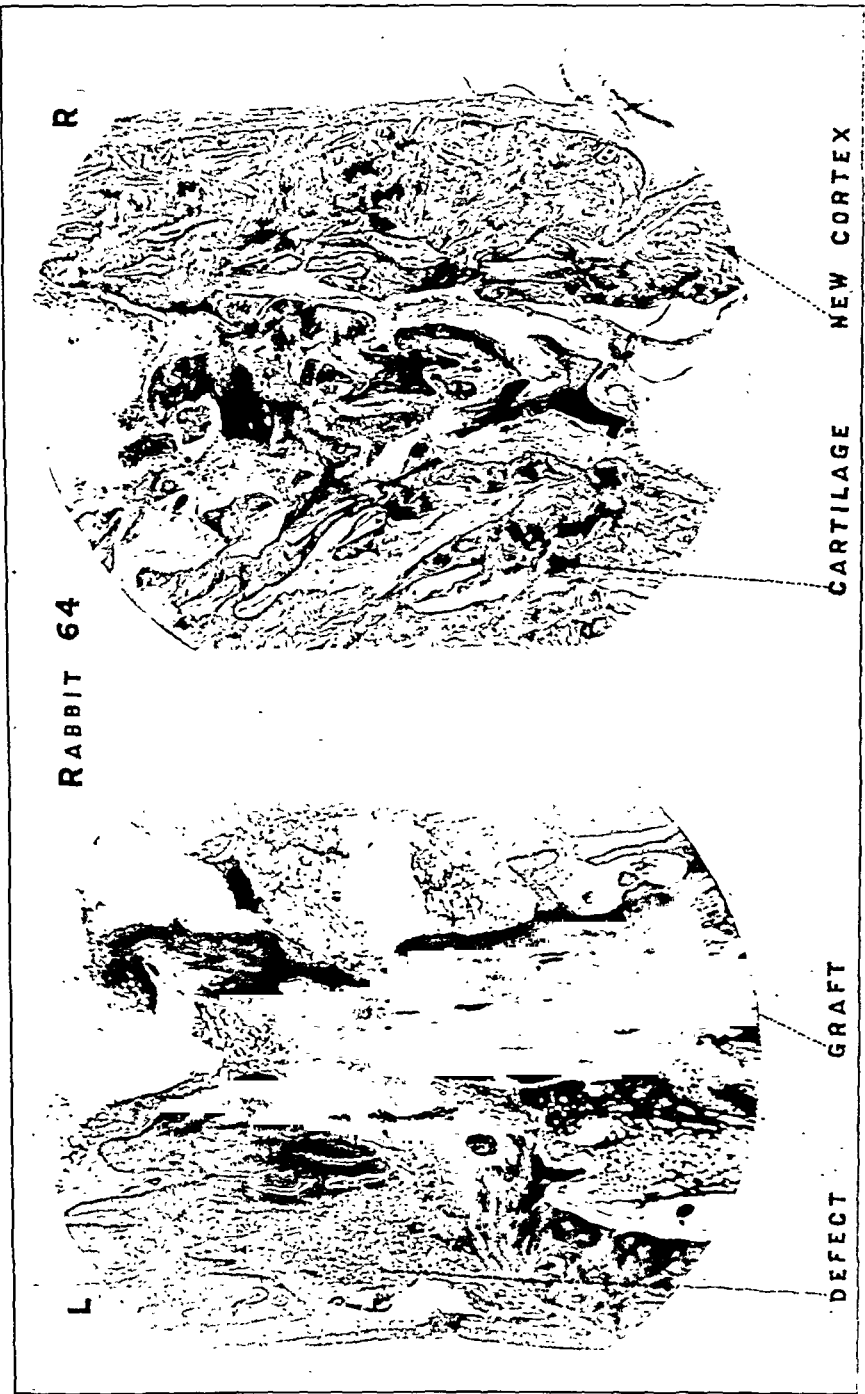


FIG. 4  
Experiment 64. Photomicrographs.

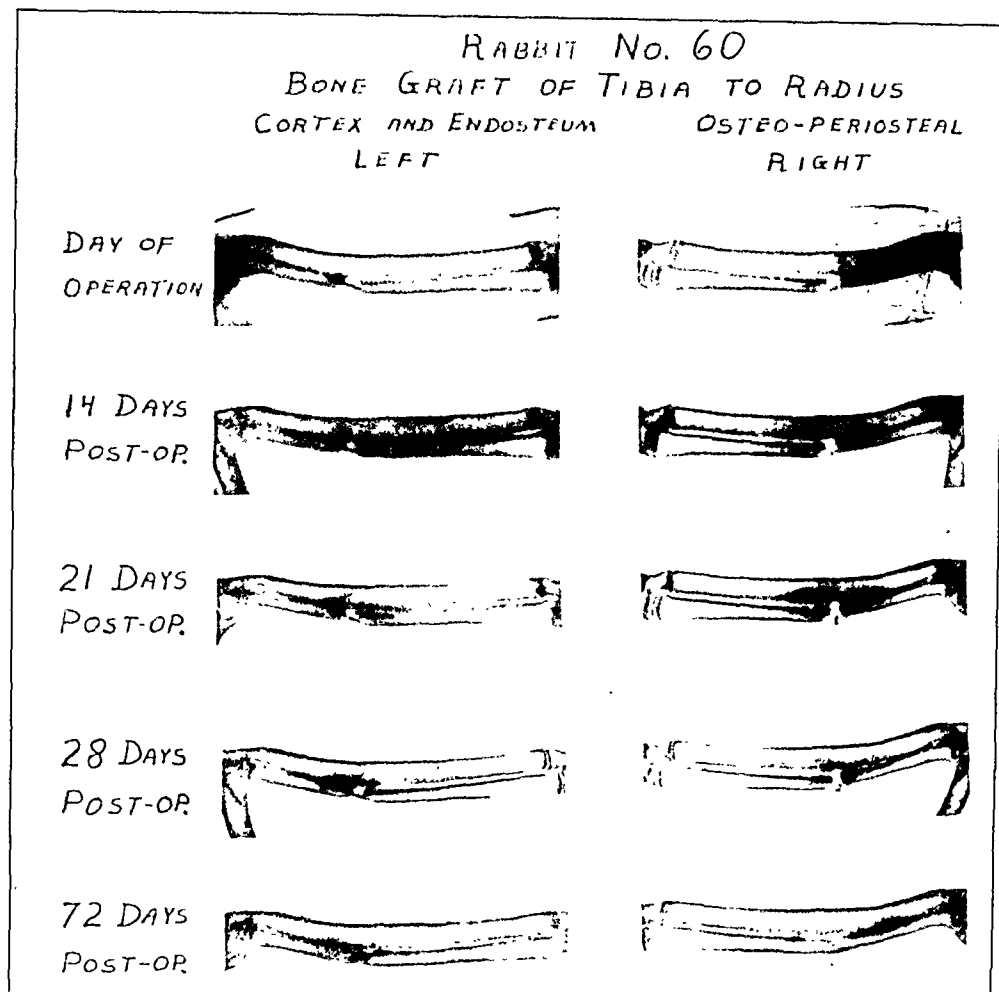


FIG. 5

Experiment 60. Roentgenograms.

defect in the left radius was delayed and apparently received little assistance from the graft of cortex. Photomicrographs (Fig. 4) confirm the above observations. It would seem that no pieces of cortex had been included in the periosteal graft, since no chips of dead bone can be seen. The defect in the right radius is completely filled with callus, the actively growing character of which is shown by small islands of cartilage cells scattered through the strands of callus. On the left side the defect is incompletely closed, and the graft shows little connection with the newly formed bone.

The four other examples of the periosteal graft showed, in every case, a complete closure of the defect after three to four weeks. On the opposite side, in which a cortical graft without periosteum had been placed, the defect became closed in four weeks in one case (No. 79), but healing was delayed in another rabbit (No. 80), and was not completed in the other two experiments (Nos. 88 and 90).

C. As a comparison of the osteoperiosteal graft with one composed of cortex and endosteum, Experiment 60 has been selected. The result resembles that of Experiment 64. X-ray pictures (Fig. 5) show the gap

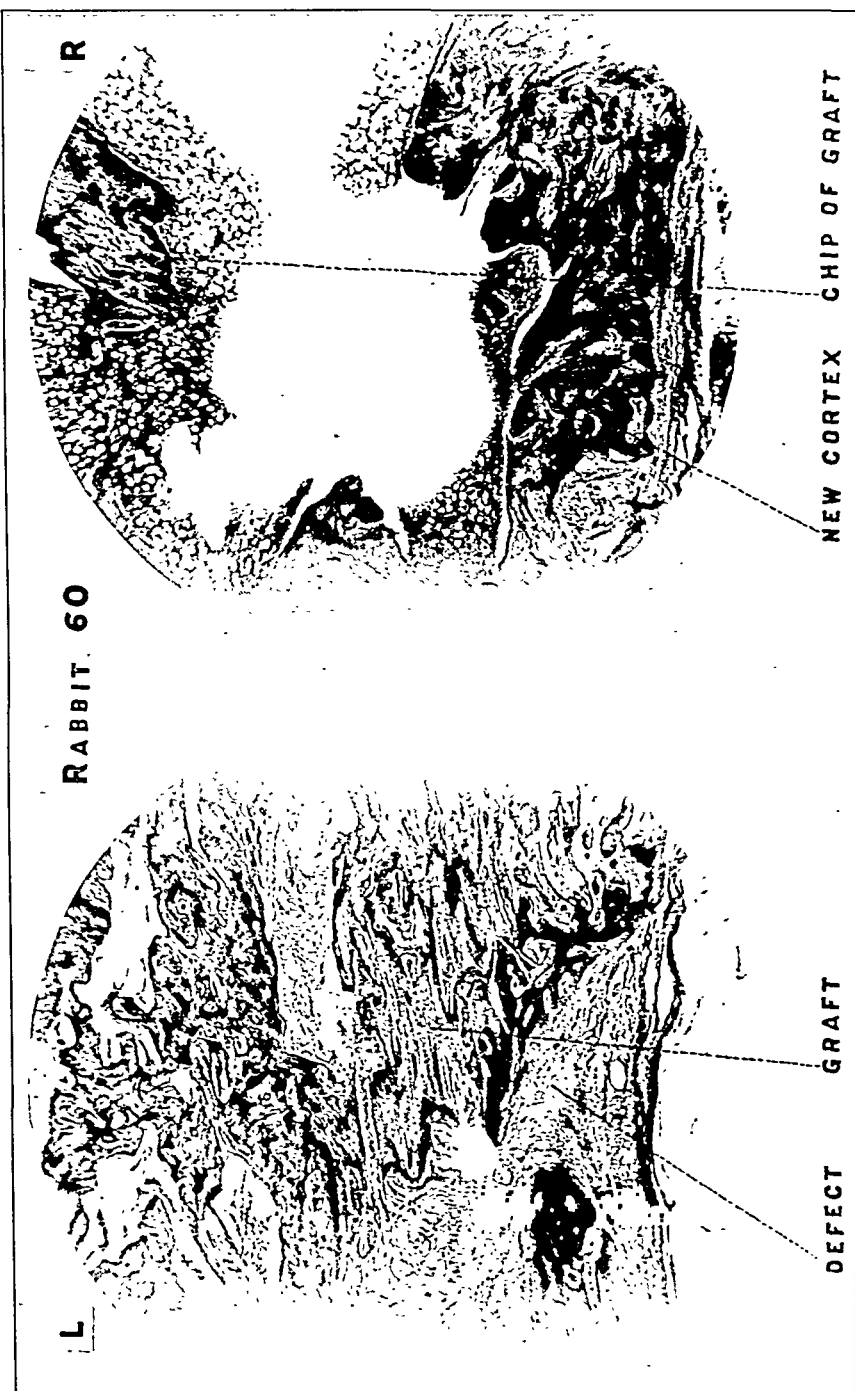


Fig. 6

Experiment 60. Photomicrographs.

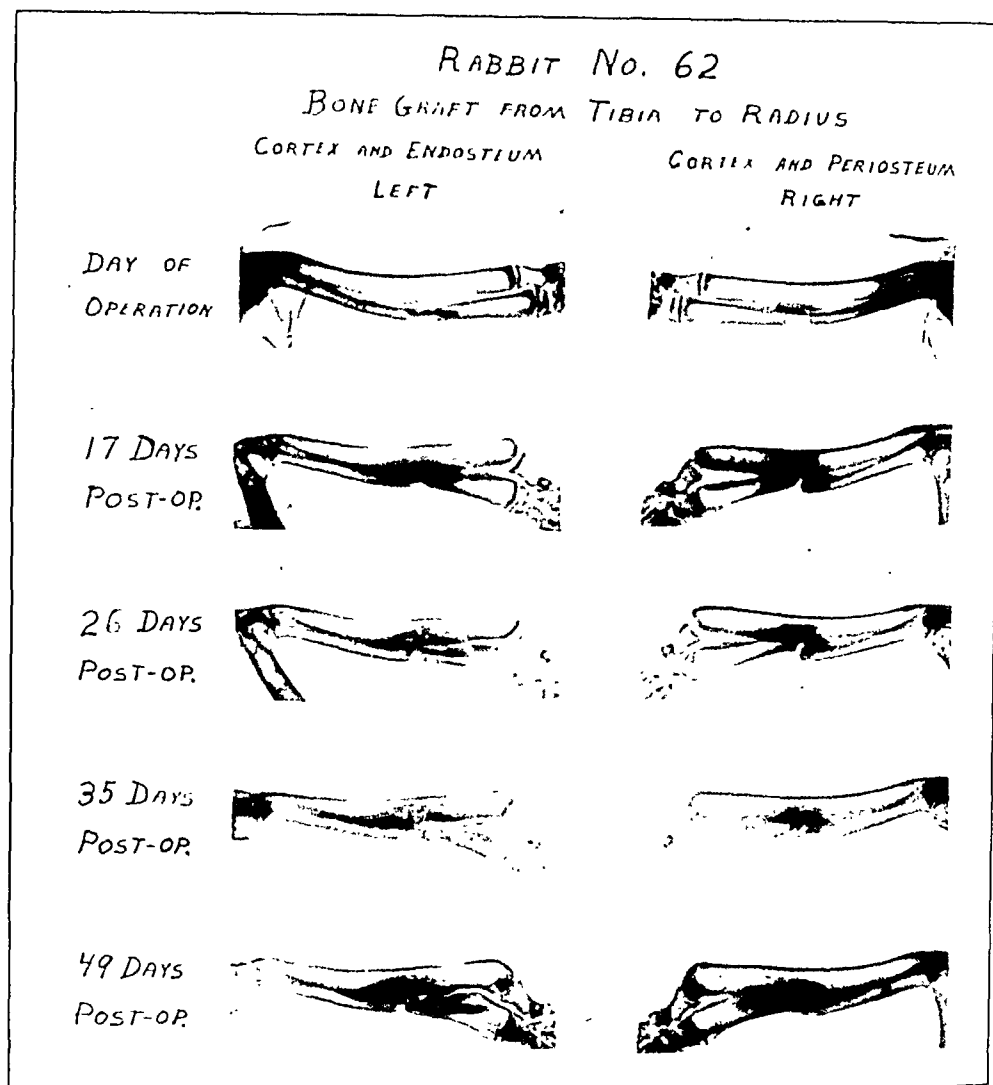


FIG. 7

Experiment 62. Roentgenograms.

in the right radius to be almost completely bridged by callus after twenty-eight days, with no visible callus on the left radius at that period. Closure of both defects appeared complete after seventy-two days. From photomicrographs (Fig. 6) it appears that the left radius has not completely united, and on this side the graft has little connection with the callus. A chip of the osteoperiosteal graft is seen to be surrounded by actively growing callus.

Of the two other examples of the osteoperiosteal graft, Rabbit 61 died four days after the operation, at which time there was no evidence of callus. The other rabbit (No. 68) showed a complete closure of the defect containing the osteoperiosteal graft after three weeks, while that containing the cortical graft required six weeks to close.

D. Three cases have been chosen to compare a graft of cortex and periosteum with one composed of cortex alone or with endosteum. In Experiment 62 the x-ray pictures (Fig. 7) show that the periosteum-covered

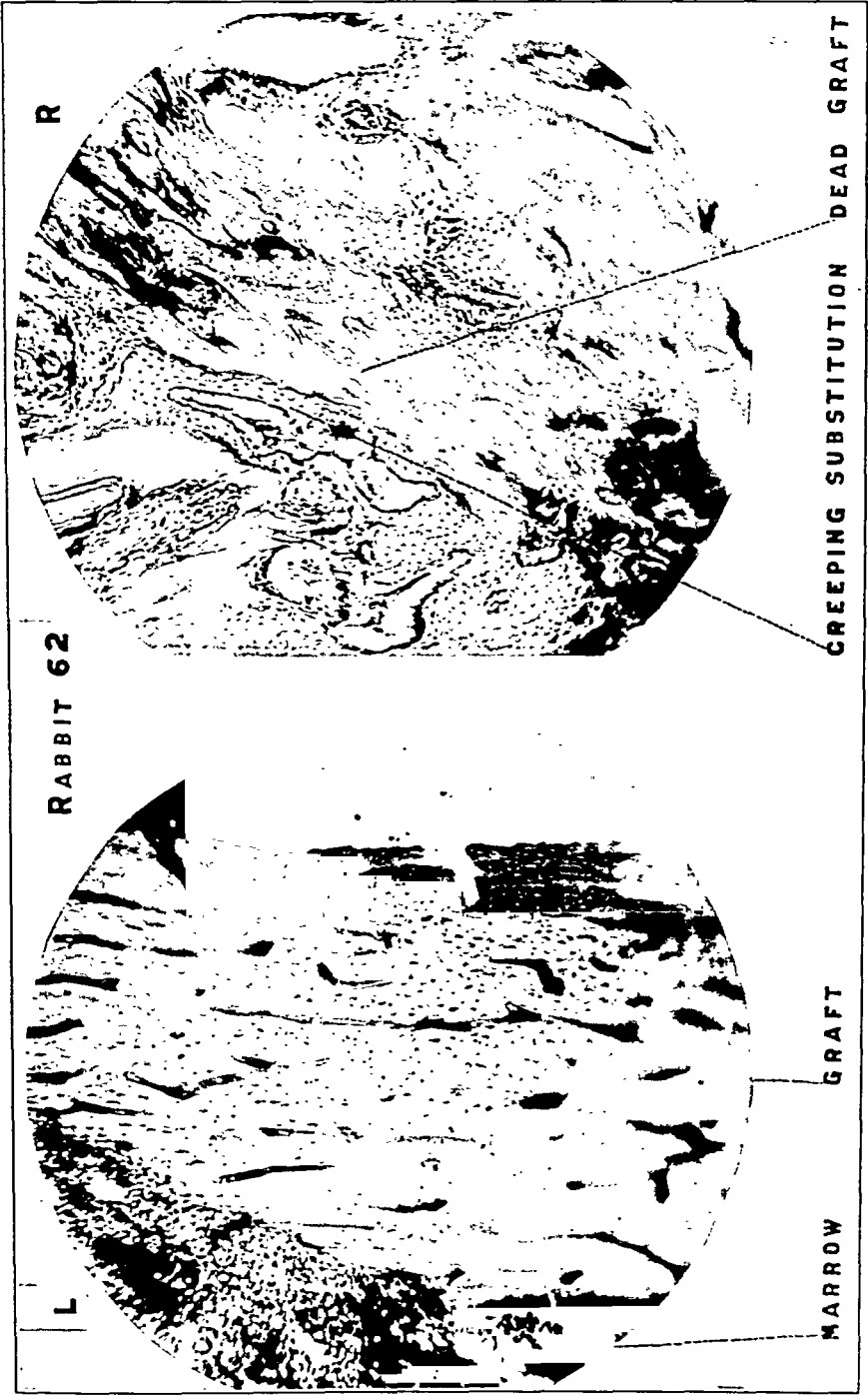


Fig. 8  
Experiment 62. Photomicrographs.

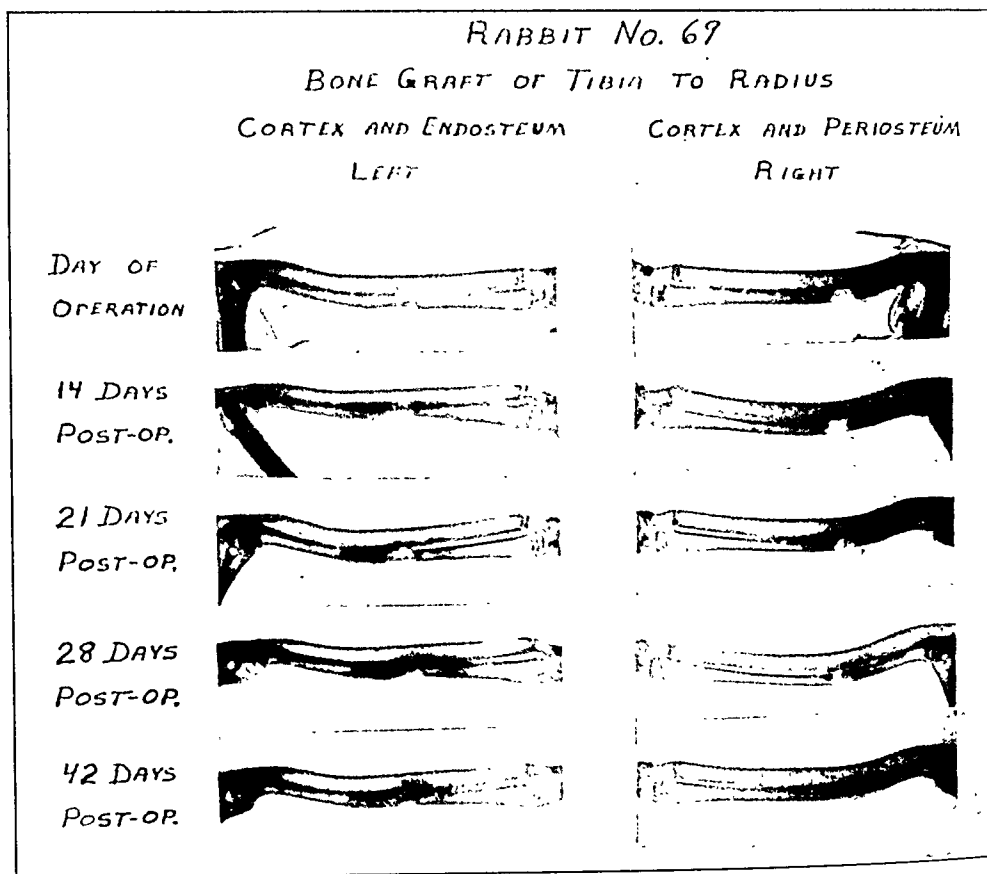
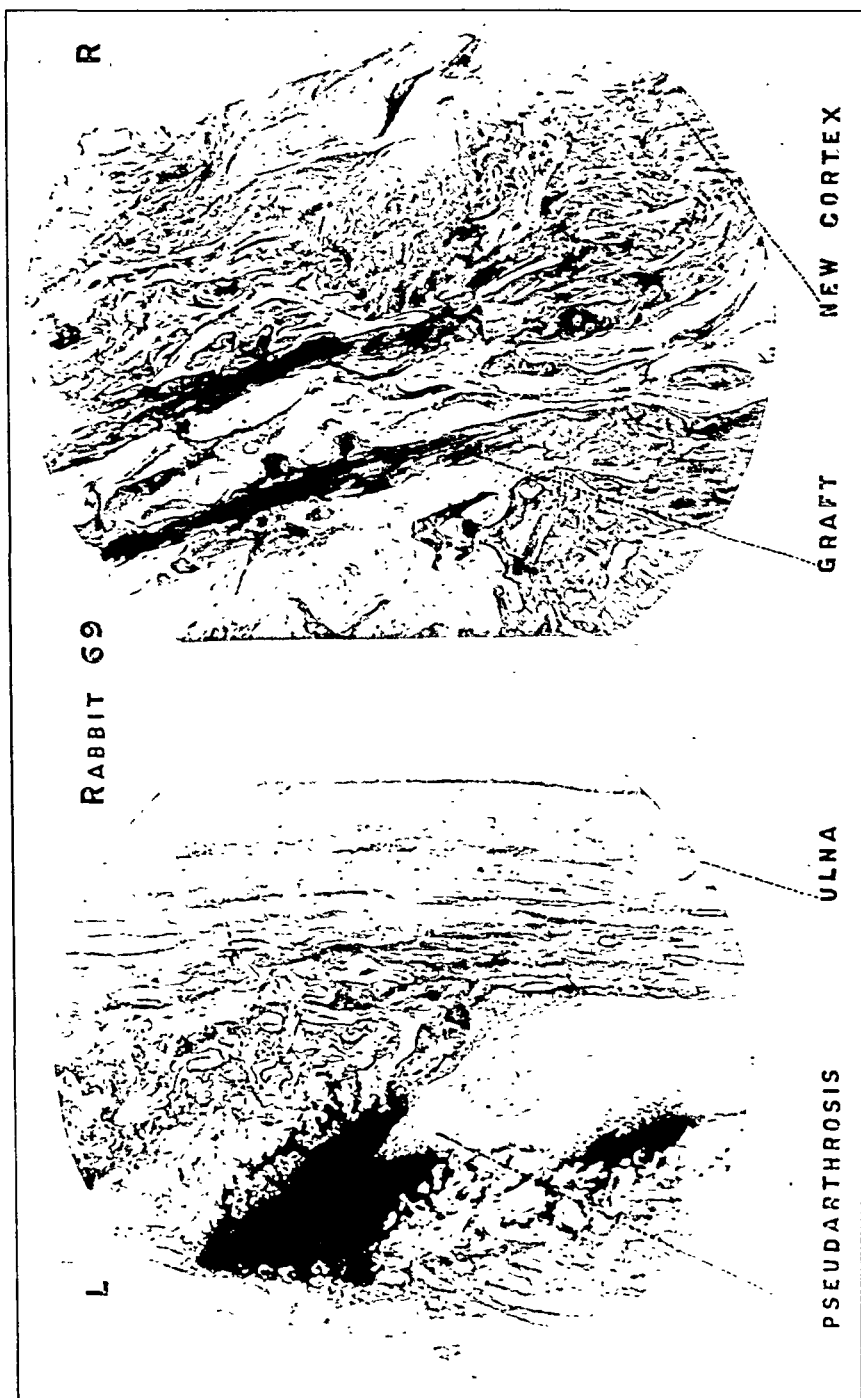


FIG. 9  
Experiment 69. Roentgenograms.

graft united with the radius and helped to close the defect, while the periosteum-free graft became loosened in its bed and migrated along the medullary cavity to the distal end of the radius. Union of the left radius did not occur. In microscopic examination (Fig. 8) the graft to the right radius is seen to be undergoing "creeping substitution",—that is, the dead cortical portion of the graft is being replaced by living bone which spreads outward through the graft from enlarged haversian canals. The entire graft in the left radius appears to be floating free in the medullary cavity.

The x-ray studies in Experiment 69 (Fig. 9) give evidence of complete closure of the defect in the right radius after twenty-eight days, while the left radius is incompletely united after forty-two days. This impression is confirmed by the microscopic examination (Fig. 10). The periosteum-covered graft persists on the right side and is intimately connected with callus. No trace of graft is found in the left radius, and a condition of pseudarthrosis is present. The black area in the latter section represents cartilage.

An earlier stage in the healing of a bone graft is presented by Experiment 87. The x-ray pictures (Fig. 11) show a faint shadow of callus on the periosteal surface of the graft in the right radius after two weeks and after three weeks. No similar callus is seen on the other graft which did not include periosteum. The microscopic appearance with high and low magnifications is given in Figures 12 and 13. In these figures, the high



Experiment 69. Photomicrographs.



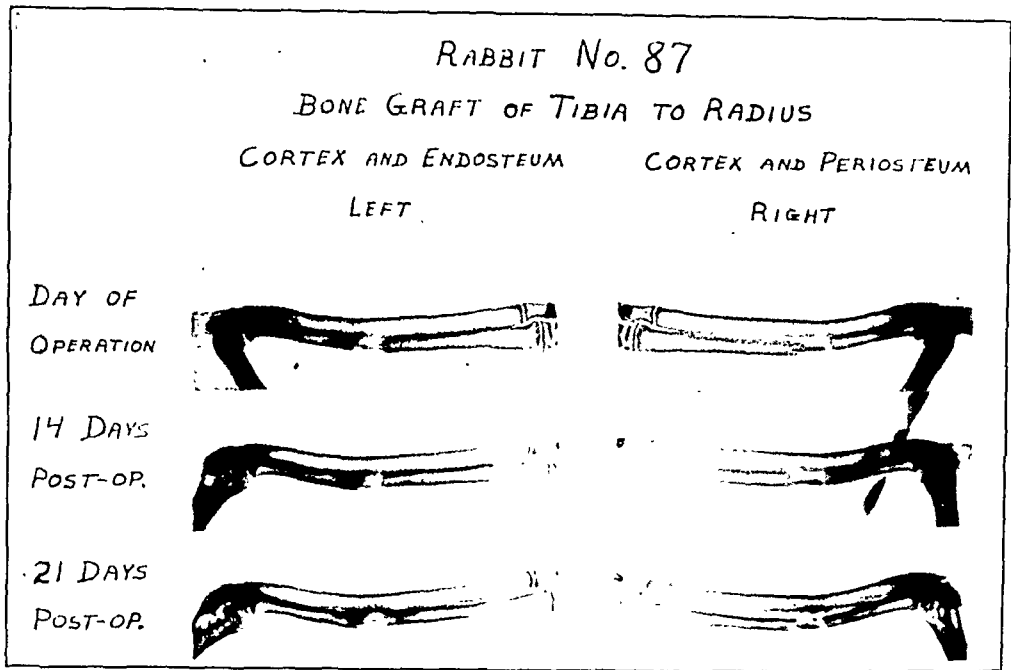


FIG. 11

Experiment 87. Roentgenograms.

magnification includes the area which is designated by the dotted circle in the low-power view. The growth of periosteal callus from the surface of the graft in the right radius is clearly shown, while the periosteum-free graft in the left radius has given rise to no such callus.

Five other cases belong in this group. In Experiment 63, both defects became closed in four weeks. Both grafts were seen in microscopic sections ten weeks after the operation, although the left periosteum-covered graft was continuous with callus, while the right graft of cortex alone lay free in the medullary cavity. In Experiment 67, closure of the defect in the left radius, in which a periosteum-covered graft had been placed, occurred in three weeks, while the defect in the right radius, after four weeks, was incompletely closed. Both defects in Rabbit 53 became closed after three weeks and a small fragment of each graft was seen after seven weeks. Rabbit 70 showed complete closure of the right radius with periosteum-covered graft after three weeks, while the left radius required six to eight weeks for healing. The graft in the right radius appeared to take an active part in the closure of the defect, while the other graft played a passive rôle. In Rabbit 86, killed after three weeks, traces of callus are seen on the graft which included periosteum, but no callus is found on the other graft.

## SUMMARY

In twenty-two rabbits, grafts taken from the tibia or fibula were transplanted to defects which had been produced in each radius. By weekly x-ray observations, and at the end of the experiment by microscopic sections, it was possible to compare different types of grafts in the same animal, namely, fibula, periosteum alone, osteoperiosteal grafts, and cortical grafts with or without periosteum.

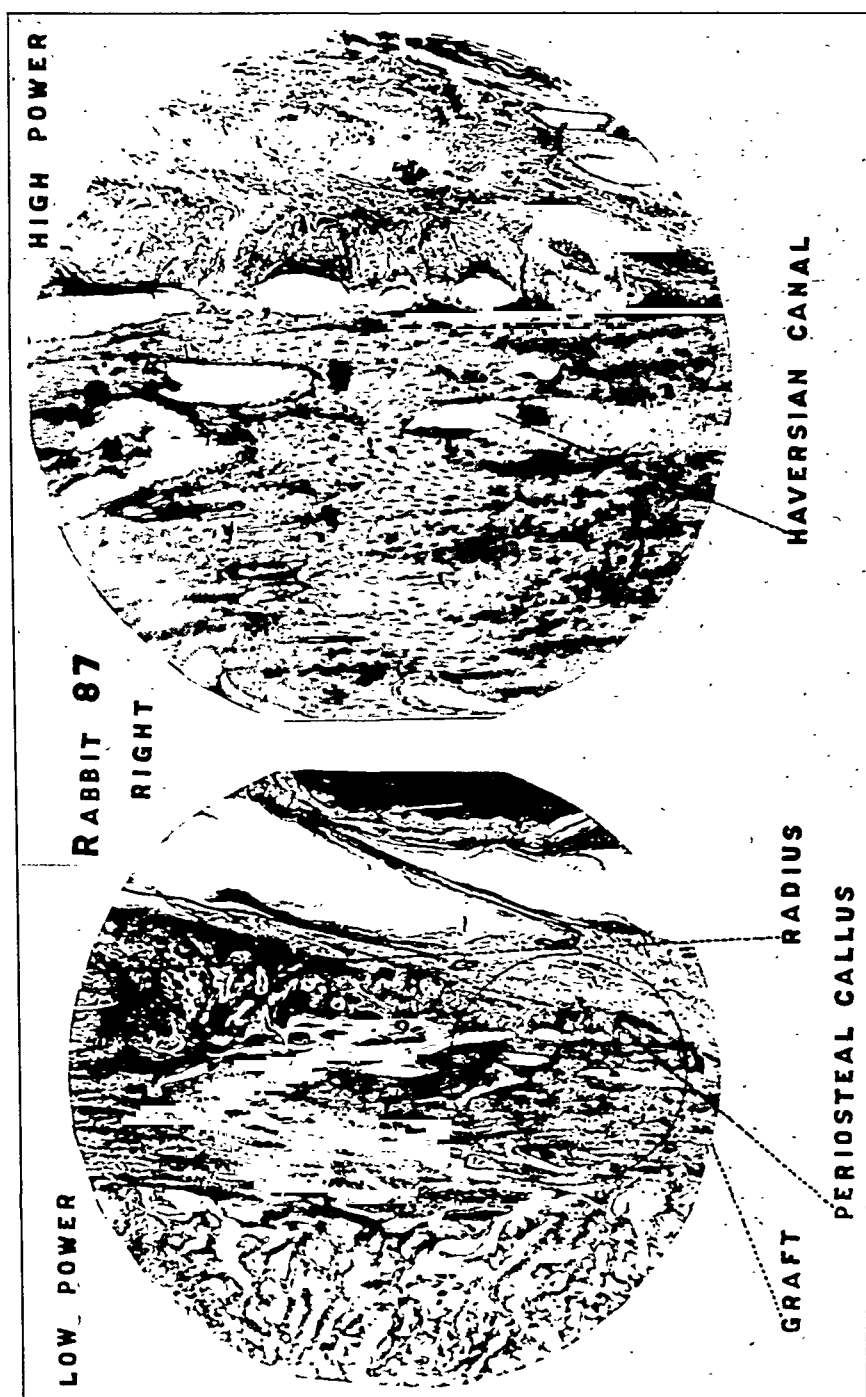


Fig. 12

Experiment 87. Photomicrographs of right radius.

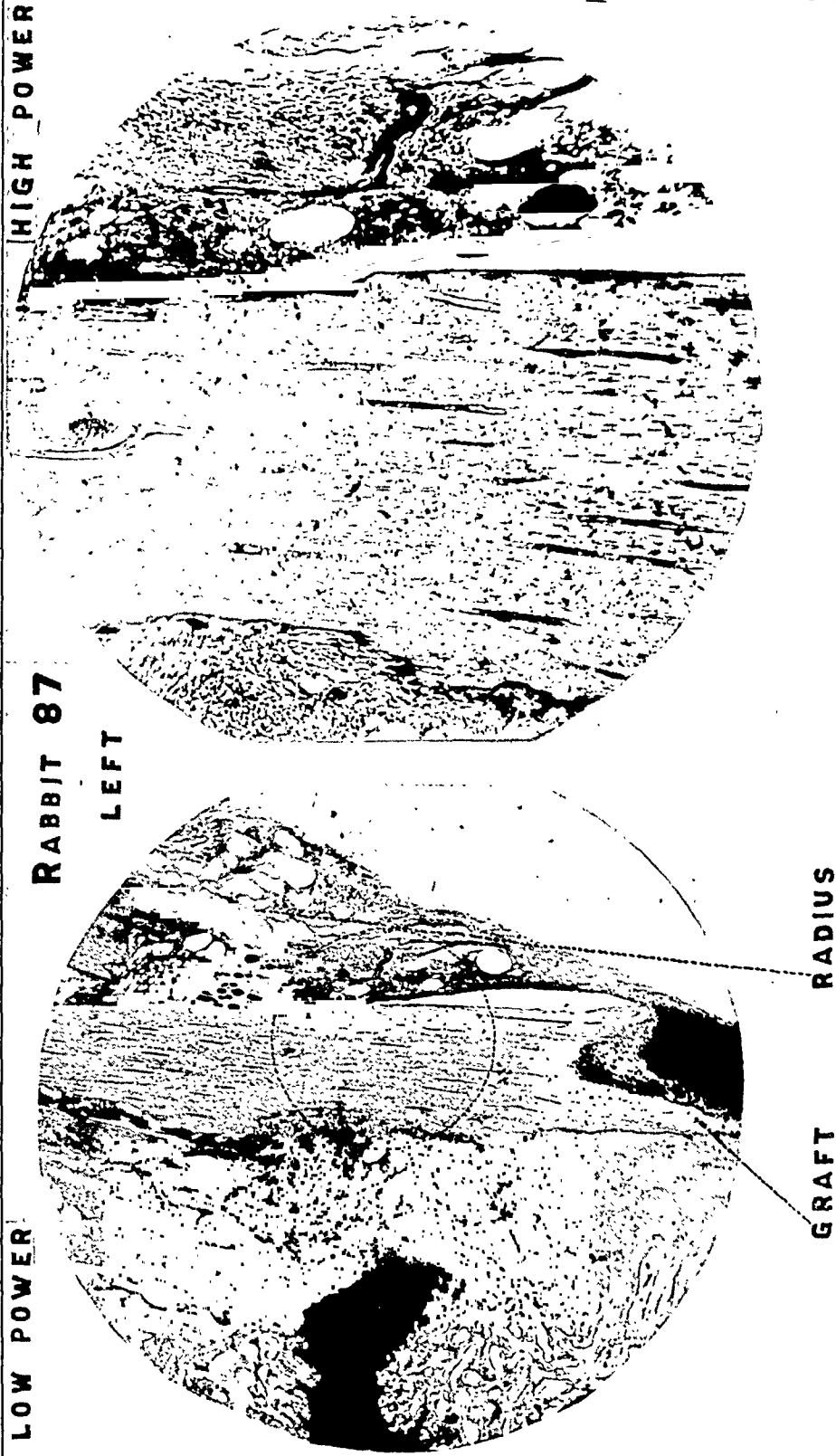


FIG. 13

Experiment 87. Photomicrographs of left radius.

It was found that a graft composed of the entire fibula survived longer and favored an earlier closure of the defect than did a graft of fibula without periosteum, or split fibula. A periosteal graft, free from bone, produced an early closure of the defect in every case. The osteoperiosteal graft also resulted in an early closure of the defect, apparently through the activity of the periosteum rather than the fine pieces of cortex which were included in the graft. A comparison of cortical grafts with and without periosteum showed clearly that the presence of periosteum on a graft favored the early closure of the defect and the survival of the graft.

#### CONCLUSIONS

1. Periosteum is the most important part of a bone graft, both as regards union of the fractured bone and survival of the graft.
2. In the absence of periosteum on the graft, union of the fracture is delayed or fails to occur, and the graft dies and is finally absorbed.
3. The bone cells of a graft die within a few days, after which the framework of the graft may be revitalized with living bone cells which spread outward from enlarged haversian canals; this process being called "creeping substitution".

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# TRACTION-SUSPENSION TREATMENT IN FRACTURES

## CERTAIN COMMONLY NEGLECTED FACTORS

BY ROBERT H. KENNEDY, M.D., NEW YORK, N. Y.

*From the Surgical Service of the Beekman Street Hospital*

The treatment of many fractures of extremities by traction suspension is one of the few developments of the war period, the value of which has been proved by its continued use in civil practice. Improvements in this method have been made since the War. Those who have had the opportunity to use it frequently and to learn its finer points find that it gives good results. Those who use it occasionally or carelessly are prone to belittle its value and to turn to other methods. It is no easier and requires no less training than open reduction. It perhaps presents less danger of a bad result for the surgeon who only occasionally treats a major fracture.

For the past nine years the same group of surgeons have been treating fractures at the Beekman Street Hospital, where the admissions are largely the result of traumatism. During this time over 3,500 fractures have come under our care. These injuries are often compound and come from a district where gas-bacillus infection is a frequent complication. We have a single operating room which is used for all types of cases. For these reasons we have not sanctioned open reduction as a routine. Once converted to traction suspension as an accepted method of treatment, we have developed a certain proficiency in its use, so that it is probably employed in some cases where other surgeons might not consider it necessary. During this period it has been used on over 200 patients, a number of whom have had traction on more than one extremity. Our aim in all cases is restoration of length and proper axis without rotation. Attention will be directed to certain errors noted as a result of this experience.

### 1. *Delay Before Application of Traction.*

We believe that traction should be applied at the site of accident no matter if, at a later date, some other method should be substituted. Findlay<sup>1</sup> of the Beekman Street staff has published the details of the routine which is used by our ambulance surgeons. As a result of following this plan, the roentgenographic examination which is made immediately after the patient reaches the hospital rarely shows overriding, and the muscles do not have a chance to go into spasm. Pain and shock are markedly less when traction and morphin are used, and the patient is ready earlier to be put into permanent apparatus. Less weight needs to be applied than is the case if even one hour elapses before traction is instituted. After twenty-four hours fifty to one hundred per cent. more weight is required to overcome the shortening. This means added and

unnecessary strain on muscles and ligaments, as well as increased discomfort to the patient.

## 2. *Lack of Continuity of Traction.*

The emergency traction must be continued until the permanent method of treatment is instituted. Our resident surgeons are allowed to release traction only if this is necessary to determine the site to be subjected to roentgenographic examination, after which it is immediately reapplied. The roentgenogram is taken with emergency traction in place. In the ward the clothes are cut away and the shoe removed under supervision of a surgeon and traction on the extremity is maintained manually whenever the hitch has to be loosened. The hitch is reapplied as soon as the extremity is freed of clothing.

When traction is the treatment decided upon, constant watchfulness is necessary in order that the desired pull be actually exerted. The pulleys must be so made and the rope of such a size that the latter does not slide sidewise and become caught between the sheave and the frame of the pulley. Knots and spreaders must be far enough distant from pulleys so that they do not engage against one another. The ropes attached to weight bags must not be so short that the bag becomes engaged in the pulley, nor so long that the bag can rest on the bed or the floor. Until we insisted that the same nurses remain on the fracture ward for long periods, we frequently found that when a patient complained of pain the nurse put the bag of weights on the bed to "let the patient rest for a while". If the distal end of a Thomas splint is allowed to rest against a pulley or a cross bar, the traction becomes fixed, rather than suspended, and the amount of actual pull is changed. After adhesive plaster with traction has been applied for two or three weeks, it will often separate from the skin quite suddenly letting up all traction and possibly allowing change of position of the fragments. This accident may be forestalled by watchfulness. All these errors seem unnecessary, but we have seen each of them occur. Although one man should have charge of the handling of an individual fracture, it is necessary that every intern, nurse, and orderly should know the rudiments of what we are trying to do and be ready to remedy any defect at any hour of day or night. The resident should inspect every traction apparatus on his morning and evening rounds for just such irregularities.

## 3. *Improper Amount of Weight.*

There is no routine amount of weight for a given fracture. This depends on the site of the fracture, the amount of muscle damage, the length of time since the fracture occurred, the weight and muscular power of the patient. Intertrochanteric fractures of the femur and fractures of the upper third of the leg require less weight than fractures lower down in these bones. A severe compound fracture with tearing or débridement of major muscles may not require as much weight as a simple fracture with little muscle damage. In a fracture in the same location, one should

not apply the same amount of weight to a one-hundred-pound girl as to a two-hundred-pound stevedore. The aim, in an early case, should be to restore the normal length of the extremity in not over six to twelve hours after traction is applied, and then to maintain it until union is obtained. Any extremity can be restored to its original length, after fracture, by traction methods, if union has not taken place. I have seen a fractured femur six weeks after injury with overriding and callus demonstrable by x-ray, pulled down to its original length by skeletal traction in forty-eight hours, without evidence of muscle damage. In a fresh case, if length has not been restored in twelve hours, either the wrong method of traction has been used or too little weight has been applied.

A common reason for failure to obtain restoration of length with traction is that adhesive plaster is used for fractures in which the weight that may be applied to it is insufficient to bring about reduction. In general, traction by adhesive plaster requires twice as much weight as skeletal traction to exert the same action on the bone. Fifteen pounds with skeletal traction applied over a number of weeks is common practice in a fractured femur. It would be a most exceptional case in which thirty pounds could be applied through adhesive plaster for a like period. Twenty-five to thirty pounds with skeletal traction is not unusual at the start of treatment of a fracture of the femur. One would not expect to be able to use fifty or sixty pounds with adhesive plaster. Some would use less; the distal fragment would not come down and the method of treatment, rather than one's surgical judgment, would receive the blame.

It is equally true that too little weight is often applied in skeletal traction. If overriding is still present after twelve hours, a small amount of weight is added; and, even then, one is surprised to find overriding still present after twenty-four hours. The fact has been forgotten that each added hour in which the muscles have been allowed to shorten requires a proportionately greater weight to overcome this shortening. The same lower leg which will return to its normal length with the application of ten pounds of traction immediately after the accident may require twenty pounds to do the same thing after twenty-four hours. If one keeps adding a pound or two of weight at intervals, one may be just behind nature in her shortening up of muscle and not obtain the desired length.

The error of insufficient traction appears just as frequently in another way. At the end of six hours it may be found by x-ray that the proper length has been obtained. The weight is then reduced too much at one time and the roentgenogram taken the next day shows marked angulation or overriding. I have seen a transverse fracture of the femur with overriding become a hair line with perfect apposition under sufficient traction, only to find, twenty-four hours later, that overriding had reappeared as a result of removing too much weight. More weight than on the first application is then necessary to bring the fragments back to the desired position. The principle is to apply sufficient weight to reduce over a short period, and lessen the weight gradually over a longer period.

When the patient complains of pain at the site of fracture, it almost invariably means that more weight is needed rather than less.

Overpull is not as common as insufficient traction, but the fear of it has probably kept more men from using this mode of treatment. It may be due to overenthusiasm with lack of experience, but more commonly to lack of frequent confirmation by x-ray. I have seen it occur apparently as a result of greater muscle injury than one suspected, so that less than the usual pull was required at the start. If overpull is present for more than a few hours, the extremity does not usually shorten on lessening the weight; the x-ray continues to show space between the fragments and union is delayed while this fills in with callus. I have not seen non-union occur under these circumstances. The moral is to check daily by roentgenographic examination while making any changes in the amount of weight, and then at least every five to seven days. The larger one's experience, the more seldom overpull occurs; it is a rare occurrence anyway, and the disability is no greater if the injured leg is one-quarter inch longer than if it is one-quarter inch shorter than the opposite side.

#### 4. *The Use of Adhesive Plaster.*

Adhesive plaster is in common use as skin traction and works well within limitations. Zinc-oxid plaster should not be used, but a good grade of moleskin plaster. The part should be shaved, cleansed, and dried before its application. The plaster should start several inches above the site of fracture, unless that means crossing a joint. The theory that the plaster should start at the level of the site of fracture is a fallacy. In children under five years of age or of comparable size, overhead suspension by adhesive plaster for a fracture of the shaft of the femur gives excellent results. Both lower extremities must be suspended or one does not get the full benefit of body weight as countertraction, and rotation of the fragments is liable to occur. The weight should be such that the buttocks are at all times free from the bed. Adhesive-plaster traction is often the method of choice in fractures of the shaft of the femur between the ages of twelve and twenty, when traction may be necessary and skeletal traction is inadvisable because of possible interference with growth from insertion of tongs or pin near the epiphyseal line.

Skin traction is usually sufficient in intertrochanteric fractures. In the adult, its use should be discouraged in all other fractures of the shaft of the femur. The weight required is more than the skin will usually stand for the necessary time. As the plaster gradually comes away, blistering and denudation of skin is frequent, requiring delay before the re-application of the plaster. In the upper third of the leg adhesive-plaster traction is usually sufficient, if any is needed. But in the lower two thirds of the leg it is insufficient, because, as with the femur, more weight is required than the area of skin will stand. In the upper extremity sufficient traction can usually be applied through adhesive plaster.



### 5. *Improper Apparatus or Improper Use of Apparatus.*

There are many types of tongs, pins, and wires which are good. Some have one advantage, others another; none is ideal. Better results are probably obtained by learning the use of one tong or pin thoroughly than by constantly changing as new ones are devised. Certain ones are absolutely to be avoided. One should not use the type of Steinmann pin which is made in two parts and screws together at the center. Such a pin is too weak. One was put in at our hospital by mistake a few years ago and it broke in the middle after a few days. Several months later an abscess developed in the center of the os calcis about a small piece of metal which had remained in. It is inadvisable to use tongs with long points. They are apt to pierce too far into the bone. We tried tongs in the malleoli for leg fractures for some time, but discarded this method several years ago, as the tongs were too prone to slip out. The Pierson leg piece is a necessary adjunct in skeletal traction on the femur or balanced traction on the leg, but it is rarely attached at the knee joint. One forgets that the joint is approximately opposite the tubercle of the tibia and the piece is usually seen attached much higher. The Pierson leg piece was devised so that movement at the knee joint might be kept up during treatment. Its use is all too often a matter of form only, as examination of the ropes, weights, and suspension of the splint will show that knee motion of more than five to ten degrees is an impossibility. With the proper application of apparatus, the patient must be instructed how to move the joint at regular intervals. If a full ring Thomas splint is used, care should be taken that it is large enough for comfort. Traction is not exerted against the tuber ischii in suspension treatment unless fixed traction is used. Ropes and pulleys should be attached so that traction is exerted in a straight line with suspension at ninety degrees. Otherwise, one cannot know what pull is actually being exerted and in what direction. Theoretically pressure pads seem useful, but in practice it is the exceptional case in which they actually improve position. Their place in relation to the site of fracture should always be controlled by x-ray.

### 6. *Nursing Care.*

Interested nursing, with understanding of what the surgeon is trying to do, is absolutely necessary. It is impracticable to attempt to have every nurse in a hospital care for fracture patients. A person who will pay constant attention to details is needed. The nurse must know when any change has occurred in the conditions of traction, and be taught to distinguish between those things which she may adjust herself and those which require the attention of the surgeon. If the patient is lying on a pelvic ring, the skin can be kept in perfect condition by seeing to it that the same area of skin does not continuously come in contact with the ring. Hammocks beneath an extremity in a splint must be kept taut so that the extremity lies on a flat surface level with the bars of the splint and not

in a gutter. The latter position favors angulation and changes the lines of force. To obviate it usually requires tightening the hammocks more than once a day. Most patients do not need to lie flat on the back constantly.

#### 7. *Neglect of Combined Methods of Treatment.*

Methods of traction may and often do reduce displacements in fractures. But knowledge of this fact should not keep us from using manual reduction under anaesthesia in combination with it in certain cases, particularly in the early hours of treatment. This is attainable without removing the extremity from its suspension splints. Following the open reduction of a fracture, traction methods are often more advisable than plaster-of-Paris splinting. Coaptation splints will sometimes assist in preventing angulation in traction cases, particularly in humeral shaft fractures.

#### 8. *The Use of the X-ray.*

It is questionable whether traction treatment should ever be used unless a portable x-ray outfit is available. Movement of the whole bed to the x-ray room in these cases is rarely satisfactory. It is necessary to have the fracture roentgenographed at least every twenty-four hours until the desired position and amount of weight are attained and maintained. After this there should be a roentgenographic examination at least weekly until firm union is present. Any change in weight applied requires reexamination by x-ray. Roentgenograms in two directions are necessary at all exposures. Lack of roentgenograms at sufficiently frequent intervals has jeopardized the result in many traction cases, just as it has in plaster cases. The presence or absence of callus as shown by the x-ray cannot always be used as a criterion for removing traction. Firm union may be present, while the roentgenogram still fails to show an appreciable amount of callus.

#### 9. *Care of Wounds.*

In fractures compounded from the outside, proper surgical treatment of the wound is essential until the danger of infection has passed. However, traction sufficient to bring about the normal length of limb lessens the likelihood of infection by improving the circulation of blood and lymph and permitting the soft parts to resume their normal relations. In the care of wounds made by tongs and pins, dressings, when necessary, should be done with meticulous care by one person only.

#### 10. *Physiotherapy.*

One of the reasons advanced for the advantage of traction treatment over plaster methods is that it is possible to apply local treatment to the part. Too often this is neglected for the first week or two, the only time when it is of any particular importance. Local heat should be given frequently after the first twelve hours. Superficial massage should be

commenced at least within twenty-four to forty-eight hours. By this method, plus elevation of the part, a few days at most suffice to remove most of the evidence of swelling in the limb. If the use of heat and massage is delayed for seven to ten days, a long period of time may be needed to remove the swelling and its results. Passive motion should be discarded, at least until firm union is obtained. On the other hand, guided active motion must be encouraged from the first, for active motion is far more important than all the other methods of physiotherapy combined. The patient should also be instructed to exercise his three remaining extremities and neck and back muscles regularly each day, in order that his general muscular tone may be preserved as much as possible.

#### 11. *Removal of Traction.*

Traction should be continued until union is sufficiently firm to maintain the same position of the fragments after the weight is removed. It is preferable to maintain traction for too long a period than otherwise. If, after removal of traction, overriding of an oblique fracture, angulation, or fracture of callus occurs, a good result may be lost or the progress of healing set back many weeks, whereas traction for one or two weeks longer might have prevented this. If retentive apparatus is to be used following removal of traction, this should be ready before traction is removed and should be applied immediately. One must remember that in examining an extremity in suspension for the presence of union, even though all traction weight be removed, the part may still be somewhat immobilized by hammocks and ropes and one may be thus easily led into the belief that union has progressed further than is really the case. Examination for union must be in two directions and the result should be concurred in by two surgeons.

#### CONCLUSIONS

The number and variety of the points cited above may make traction-suspension treatment sound formidable. Experience has shown that these must be frequently recalled in order to obtain the desired results. Watchful care is the main requirement. Traction-suspension treatment, with due regard for the above mentioned factors, is the method of choice in many patients to restore length, axis, and function of a fractured extremity with the maximum of comfort and safety.

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# THE TREATMENT OF COMPOUND FRACTURES

## A SPECIFIC TECHNIQUE FOR THE PREVENTION AND CONTROL OF OSTEOMYELITIS\*

BY FRASER B. GURD, B.A., M.D., C.M., F.R.C.S.(C.), F.A.C.S.,  
MONTREAL, CANADA

*From the Montreal General Hospital*

During the Winter of 1917-18, due to the interest of Sir Robert Jones, the writer had the opportunity of undertaking an experimental study on wounded soldiers suffering from infected compound fractures. The results of this study were published in 1918<sup>1</sup>.

Since the beginning of 1919, when the author returned to the treatment of civilian injuries, a definite technique<sup>2</sup> for the treatment of severe compound fractures has been employed. During this time only trivial modifications of the procedures, adopted immediately following the War, have been made. As the result of the treatment of a large number of cases during this period by himself and his immediate associates (Dr. L. H. McKim and Dr. George D. Little), and by comparison of these results with cases treated by other techniques in different clinics, the author is convinced that the results obtained by this method of treatment have, in the long run, been more favorable.

For the prevention and elimination of infection and cellulitis, we employ a technique, in the hope that the following *desiderata* may be obtained:

- I. Avoidance of Suitable Pabulum for Bacterial Growth.
  - A. Excision of devitalized tissue.
  - B. Prevention of accumulation of inert exudate and blood.  
(See II, A, 2.)
- II. Maintenance of Circulation.
  - A. Avoidance of interstitial tension.
    1. Incision of skin and fascia.
    2. Evacuation of exudate and transudate.
      - a. Obliteration of dead spaces.
      - b. Curtain drainage.
    3. Prevention of adhesion of opposing wound surfaces,—delay in sealing of wound. (See II, A, 2, b.)
  - B. Rest,—fixation.
    1. Plaster-of-Paris.
    2. Splints.
    3. Traction.
  - C. Posture,—gravity to assist venous and lymphatic drainage.

\* Presented by invitation at the Annual Meeting of the American Orthopaedic Association, Toronto, Canada, June 17, 1932.

## III. Chemical Inhibition of Bacterial Growth.

## A. Saprophytic bacteria.

1. Iodoform.

2. Bismuth.

## B. Pathogenic bacteria.

1. Iodoform.

2. Bismuth.

## IV. Stimulation of Tissue Reaction—Serous and Cellular.

## A. Iodoform.

## B. Bismuth.

## C. Liquid Paraffin.

Since the majority of cases of compound injuries occur in fractures about the junction of the middle and lower thirds of the leg, the treatment of compound fractures of both bones in this neighborhood, with severe laceration of the skin and tissues, will be considered in some detail.

TABLE I

FRACTURES OF SHAFTS OF BOTH BONES OF LEG—1926 TO 1931—CENTRAL AND WESTERN DIVISIONS—MONTREAL GENERAL HOSPITAL

*Author's Service Only*

Total no. of cases	Simple	Compound, Group I— puncture wounds	Compound, Group II— lacerated wounds	Amputations, primary	Amputations, secondary	Died
307	220	24*	47**	13***	4****	3*****

\* Many cases in Group I are not traceable, as such, and are included as simple fractures.

\*\* Includes cases of secondary amputations but not of primary amputations or deaths.

\*\*\* Includes nine cases due to wheels of trams or railroad carriages, one due to wheels of fire engine, two due to motorcycle crashes, and one following jump out of fourth story window.

\*\*\*\* Includes three cases of dry gangrene and one case of gas gangrene.

\*\*\*\*\* Includes two cases of death within ten hours from shock, and one case of death on the third day from delirium tremens. Other patients with multiple injuries died within a few hours, untreated with reference to leg, and are not included here.

It is not my purpose in this contribution to discuss the treatment of shock *per se*. With as little delay as possible, the patient is taken to the operating room. The author is convinced that it is always advisable to treat the mutilated extremity at the same time as the more important resuscitative measures are being carried out, rather than that time be spent in overcoming shock prior to the initiation of operative measures.

Under gas-oxygen anaesthesia (with or without the assistance of avertin basal anaesthesia), the preliminary splinting is taken off and, unless the clothing has been removed immediately following injury, this is also cut away. The employment of novocain or avertin to fortify the effects of the gas and oxygen may, in certain cases, be necessary and is often helpful.

Too much stress cannot be laid upon the general toilet of the ex-

tremity, more particularly in the employment of soap and water cleansing and careful shaving of the skin. The limb in the neighborhood of the injury, and the wound itself, are then generously cleansed with petrolic ether and the whole surface dried before the use of alcohol. Although by no means convinced that iodine is of greater value than the other skin antiseptics, in view of the fact that iodine in the molecule of iodoform is to be used later in the treatment of the case, the author has felt it advisable to rely upon this substance for skin sterilization in traumatic emergencies. Moreover, there is no reason for avoiding the introduction of tincture of iodine into the wound itself.

The first stage in the operative interference consists of the excision of the narrowest possible edge of the contaminated and crushed skin. The skin wound is then enlarged in such a way that complete exposure of the underlying structures is brought about. Although enlargement of the wound is, in part, made in order that exposure of the deep structures may be adequate, the more important reason for incision is in order to anticipate interstitial tension which, it must always be assumed, is likely to take place during the first few days following injury. Adequate skin incision having been accomplished, the deep fascia is split well beyond the zone in which it is thought probable that inflammatory oedema of the tissues may occur. All obviously contaminated muscle and fascial tissue is excised, together with such muscle masses as appear to have been devitalized by crushing. Incompletely separated bone fragments, whether large or small, which show any attachment to any tissue whatever are allowed to remain in place. The surface of grossly contaminated fragments is removed by means of the rongeur.

At this stage of the operation all grossly contaminated and crushed tissue has been removed, all bleeding points have been clamped and certain of them ligated. A large surface wound has been made and, in so far as possible, the wound has been rendered saucer-shaped or funnel-shaped in appearance. Fractured bone ends have been brought under adequate vision. If nerve injury has occurred, as careful suture as is possible under the circumstances has been accomplished, and torn tendon ends have been approximated.

The whole wound is then thoroughly washed with normal saline solution on large sponges. The surface of the wound is then dried and thoroughly bathed with alcohol, in order that the surface tissues may be dehydrated. With dry sponges the alcohol is then removed and bipp<sup>\*</sup> rubbed on to the surface, all excess of the paste being removed. Particular care must be paid, in the bipping of the wound, to reach all the interstices of the tissues and particularly to cover the bone fragments. The properly bipped wound will show a slightly yellowish gray film overlying all the tissues, but nowhere should yellow masses be visible.

\* Bismuth, iodoform, paraffin paste containing bismuth subnitrate 1 part, powdered iodoform 2 parts, and liquid paraffin about 1 part, or sufficient to make a thick paste. It is of the utmost importance that vaselin or paraffinum molle should not be used, as with such a vehicle an ointment which will not adhere to the raw surface results.

The wound being bipped, wide (two to four inch) soft packing gauze is soaked in liquid paraffin and a small amount of bipp \* is rubbed into it. This liquid paraffin-soaked, bipped gauze is firmly and carefully packed into the wound, the greatest care being taken to fill all crevices and small cavities in the deeper parts of the wound. In order that the packing may be held firmly in place, and in order that the skin edges may not retract unduly, a few silkworm gut sutures are employed to partially approximate the skin edges without tension. The whole pack is thus, more or less completely, buried within the limb.

At the commencement of operation, traction is exerted upon the limb, either by means of a Delbet sling on the foot, or by means of skeletal traction through the os calcis or the lower part of the tibia and fibula. At the completion of the operation a thin layer of padding is applied to the limb from the toes to about the junction of the middle and upper thirds of the thigh and a circular plaster-of-Paris bandage applied. Antitetanic serum is administered \*\* and whatever resuscitative measures have been indicated are continued.

The patient is returned to bed and the foot of the latter raised about eight inches, in order that blood and lymph stasis in the injured extremity may be limited. During the first few days following operation, it is to be expected that the plaster will become discolored, in consequence of the exudation of blood and serum. The temperature chart is watched, and only if the temperature remains above 103 degrees is the plaster interfered with; upon no account should a window be cut. If it be deemed absolutely necessary to examine the limb—which it may be added is very rarely the case—the whole anterior half of the plaster should be removed.

TABLE II

COMPOUND FRACTURE, LACERATED WOUNDS, BOTH BONES OF LEG

Total no. of cases	Average age	Average days in hospital	Average days between operation and first dressing	Average*** days before union	Second- ary am- putation	Non- union	Delayed union	Secondary removal of dead bone
47	29	53.90	18.63	66.5	4	0	4	4

\*\*\* Excluding delayed cases. Indicates clinical union, but not necessarily considered fit for unprotected weight-bearing.

The position of the bones is immediately checked by x-ray examination. Although the presence of bipp in the wound and in the packing results in a shadow, only rarely is the picture so obscured that an adequate idea of the position of the bone fragments cannot be obtained. Unless very marked deformities are seen in the x-ray examination, further interference with the limb should not be carried out before the lapse of, at

\* The maximum quantity of bipp employed should not, I believe, exceed fifteen cubic centimeters.

\*\* In very severe crushing injuries, polyvalent antigangrene serum is probably useful and is recommended.

least, ten days following injury. As a rule, the first dressing is carried out about three weeks after the primary interference, at which time a certain definite stability of the limb is usually noted.

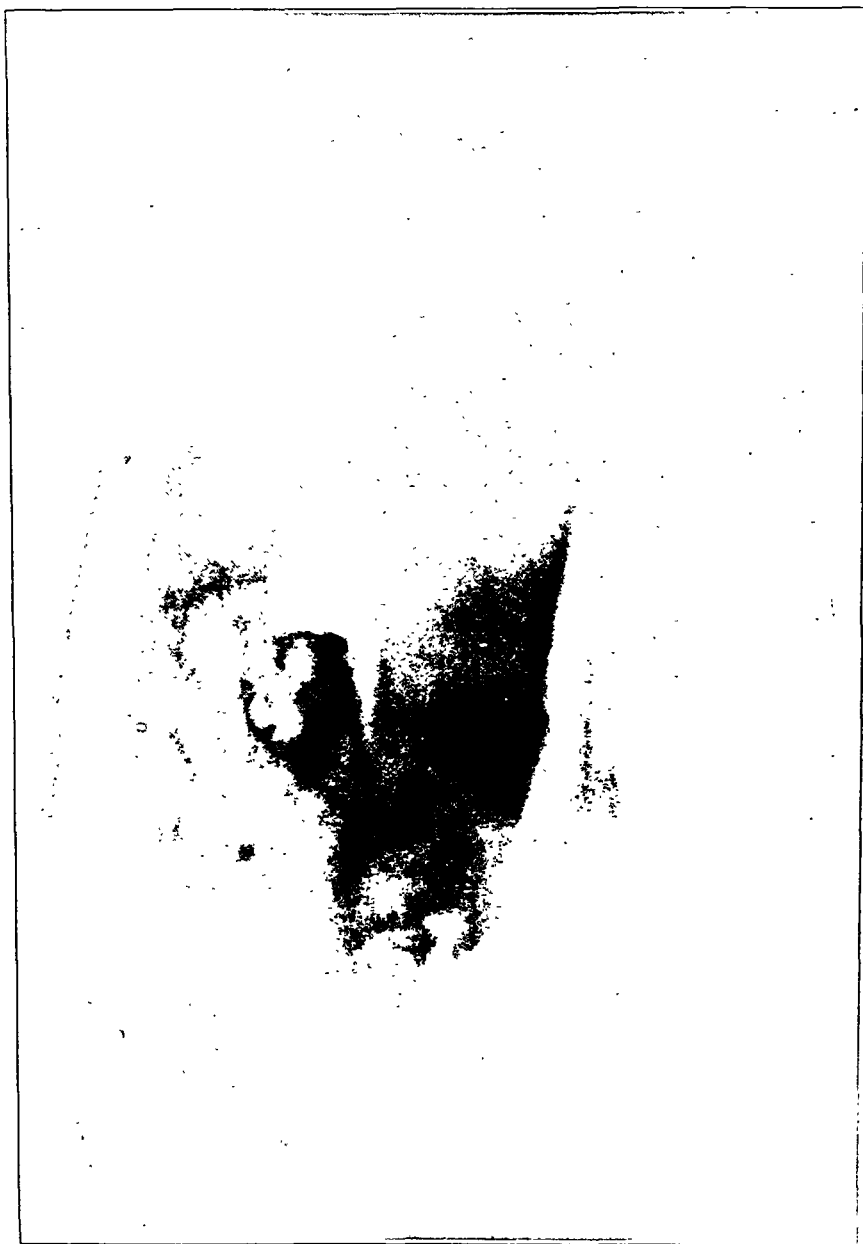


FIG. 1

Roentgenogram showing liquid paraffin-soaked, bipped pack in position. Case J. V., twenty-four years of age.—No. W-549-27. Severe compound fracture of both bones. Plastic operation three weeks after injury. Healed and union sound within three months.





FIG. 2

Roentgenogram showing bipped, paraffined, gauze pack in position. Case W. E., twenty-five years of age.—No. 4426-30. Severe compound fracture of both bones. Wound soundly healed and bones firmly united within six months.

The first dressing is carried out in the operating room; it is advisable to employ for this purpose either general (nitrous oxid and oxygen), avertin, or spinal anaesthesia.

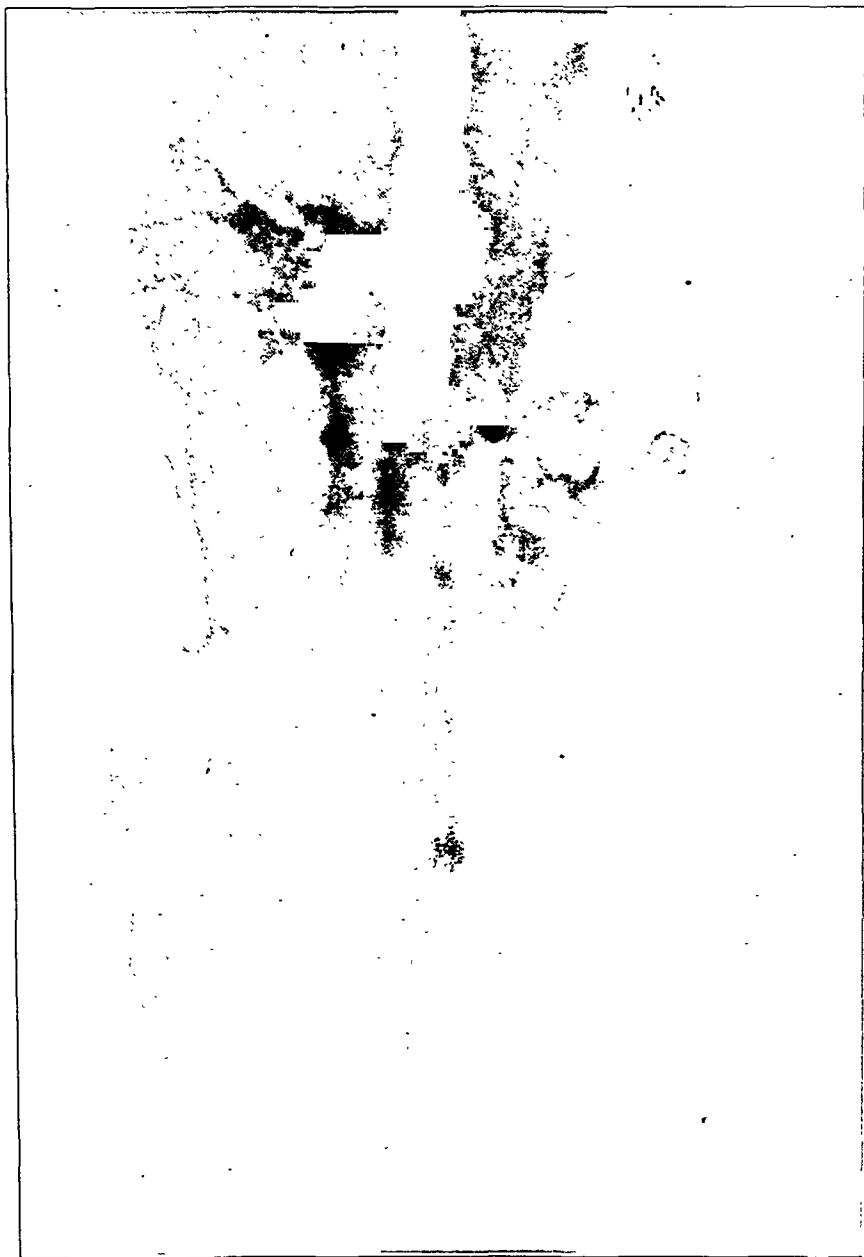


FIG. 3

Same case as shown in Fig. 2.

In order that displacement of the bone ends may not take place, a Delbet sling is applied to the foot and traction employed during the course of this interference. The sutures are removed and the whole wound thus opened up. The pack is carefully removed so as to avoid, in so far as

possible, injury to the surface tissues with consequent bleeding. As a rule, examination of the wound at this time (eighteen days following injury, more or less) shows it to be covered with firm deep red granulations, both in so far as the soft tissues are concerned and also the exposed bone. Bone fragments, which at this stage are completely devoid of granulations, should be removed.

If packing has been adequately carried out, so that no dead spaces have been present in the tissues, no purulent exudate will be found. If small areas of devitalized tissue have been overlooked at the time of the original interference, these tissue masses will, for the most part, have come away with the removal of the pack, and those remaining in the wound are removed by swabbing or blunt dissection. After hemostasis has been accomplished, by means of hot saline packs, the whole wound is mopped with alcohol and dried. Bipp is then carefully rubbed into the surface of the whole wound and the cavity again repacked with liquid paraffined gauze with a small amount of bipp added. As a rule, the amount of gauze which the wound will hold at the first dressing is approximately one-half of that which was found necessary at the original operation. Plaster-of-Paris, with a thin layer of padding underlying it, is again applied as a circular cast.

Depending upon the primary severity of the wound and the conditions as noted at operation, the period between the first and second dressings will vary. As a rule, approximately three weeks may be profitably allowed to elapse at this stage. It is usually advisable to employ anaesthesia for this dressing also, in order that adequate exposure of the depth of the wound may be carried out. Again a complete search for white bone fragments is made and loose pieces of necrotic bone removed. If suture of the superficial parts, including skin, will result in obliteration of dead space, such a procedure is carried out, after having carefully bipped the wound. If a dead space is unavoidable, this is again repacked and the wound partially sutured. At the second dressing moderately firm fixation of the fracture will usually be found to have taken place. As a rule, therefore, it is advisable at this time to apply a circular cast without padding, in order that the patient may commence weight-bearing<sup>4</sup>.

Dressings, subsequent to the second, will rarely require an anaesthetic, unless it be decided that time will be saved by secondary suture of the wound, or, as not infrequently happens, it may be judged advisable, in the presence of a large area over which normal skin has been lost over the anterior surface of the leg, to perform a plastic operation.

The interval between subsequent dressings will usually be from three to four weeks. Once moderate consolidation has taken place, the long plaster cast is replaced by a short apparatus of the Delbet type, in order that knee, foot, and ankle function may be reestablished.

In our experience, the presence of bipp in the wound or about the bone ends has not been the cause of delayed union or non-union. This fact was early established by Rutherford Morison<sup>3</sup>.

The author has previously expressed <sup>2</sup> the opinion that if more than 144 square inches of tissue are exposed to the action of bipp, definite evidence of poisoning, either iodoform or bismuth or both, may occur. If, however, the wounds be less in size than one square foot, the danger of any important injury to the patient arising from either of these drugs is, in the author's opinion, negligible; granted, of course, that the proper technique be used in its employment. The presence of a blue-black line on the gums is not, in itself, of any great importance, but should be interpreted as a sign. The presence of a marked stomatitis, with involvement of the buccal mucosa or the floor of the mouth, is, of course, to be avoided, and should be prevented in the individual case by the removal of all or most of the bipp at the first sign of tenderness of the teeth.

The development of a colitis with the exhibition of the usual symptoms of this disease is a serious matter. As stated above, however, such a complication is avoidable, nor has it occurred in any case seen by the author since his return to civilian practice. As a general statement, it may be said that since return to ordinary surgical work, and notwithstanding the fact that bipp has been employed as an adjuvant in the treatment of both abdominal <sup>5,6,7</sup> and thoracic <sup>8</sup> suppuration to a very considerable degree, the author has not seen a case manifesting either iodoform or bismuth poisoning of a grade sufficient to cause any anxiety whatever.

Although by means of the technique suggested in this contribution, phlegmonous inflammation in even severe compound fractures is almost completely eliminated, the author's experience during the War and with a limited number of cases in civilian practice, in which, prior to the cases coming under his personal observation, diffuse cellulitis and tissue necrosis had already occurred, has proven that the technique herein recommended is of value. Approximately the same method has been employed in the treatment of acute infective osteomyelitis with satisfactory results.

Essential features of the technique as applied to cases of bone infection, in which marked inflammatory changes are already present, are: incision of the tissues beyond the site of manifest inflammatory changes; adequate exposure of all suppurative loculi and interstices in the tissues; careful and complete removal of all dead or devitalized tissue; proper bipping of the whole wound and careful packing with liquid paraffin-soaked, bipped gauze. The packing is introduced in such a way that all deep-seated cavities are brought into communication with the surface. In practice, such a method of treatment results in lessening of pain and discomfort on the part of the patient; the number of dressings required is materially reduced; and, since it is recommended that the majority of dressings be carried out under an anaesthetic, there is less suffering on the part of the patient and more adequate treatment of the wound.

#### SUMMARY

In the treatment of severe compound fractures with extensive lacera-

tion and contamination of tissue, a specific technique is recommended. This method, which is essentially a modification of the procedure suggested by Rutherford Morison in 1916, is based upon the results obtained in the study of severe cases, already infected, observed at Alder Hey Military Orthopaedic Hospital during 1918. Since the War, the method has been more especially adapted to the prevention of infection and inflammation in civilian injuries.

The essential features of the technique recommended are:

1. Immediate operative interference and reduction of fracture, *secundum artem*.
2. Conservative excision and radical incision of tissues.
3. Proper bipping of the wound following dehydration.
4. Obliteration of dead spaces and prevention of adhesion of opposing wound surfaces by means of firm packing with relatively large, liquid paraffin-soaked, bipped packs.
5. Avoidance, in so far as possible, of ligatures and sutures.
6. Application of plaster-of-Paris over a thin layer of padding; no window.
7. Infrequent dressings,—the first approximately eighteen days after injury, done in the operating room under an anaesthetic; a secondary suture used and packing as indicated.
8. As soon as union commences, the application of an unpadded plaster and felt heel.

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# SPLENIC EXTRACT TREATMENT OF BONE AND JOINT TUBERCULOSIS \*

BY THOMAS F. WHEELDON, A.M., M.D., F.A.C.S., RICHMOND, VIRGINIA

## INTRODUCTION

The treatment of bone and joint tuberculosis, considered ideal by almost everyone, is not always, nor even usually, possible in these parts. The state is large; the population is scattered; hospitalization for the large number of sufferers is out of the question; and education of the laity in many orthopaedic matters is not advanced. As a result, when the very strict discipline of approved treatment is suggested, the patient or his family is often accustomed to fly to others where he feels measures of a less

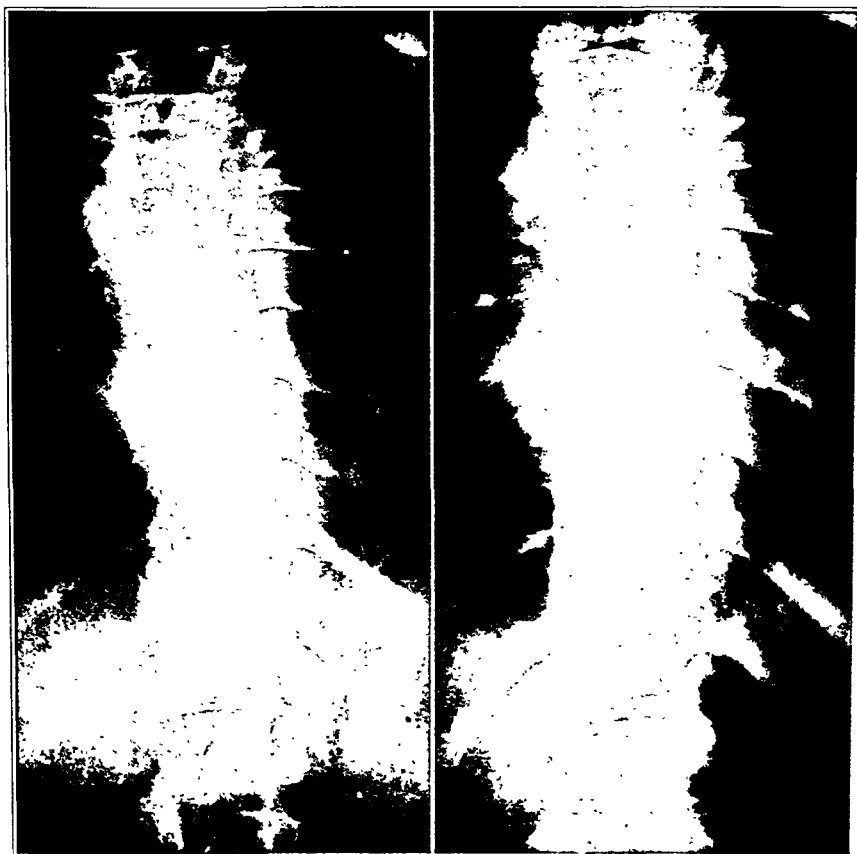


FIG. 1

Case 1 (F. B. 13092)

Left, before treatment. Right, after treatment.

\* Submitted for publication, August 8, 1932.



FIG. 2

Case 1 (F. B. 13092)

Left, before treatment. Right, after treatment.

rigid character will be instituted. The writer has in mind a boy who had been under his care for several years for tuberculosis of the knee. The family was well pleased with his progress, but later, when he developed tuberculosis of the spine and absolute recumbency in a plaster shell was recommended, the parents unceremoniously took him to another who applied a light back brace and allowed full activity. The family have found their mistake too late.

For years, then, the writer has felt that an adjuvant which might hasten healing would be a God-send. When Otto Fliegel's article appeared in the fall of 1930, it seemed as if something definite had been offered. The writer's interest was immediately aroused (and so was the interest of many others as has been shown by personal communications, although, so far as can be learned, no definite problem has been attacked elsewhere) and at once he set to work to see what could be done to institute this treatment (raw calf-milt diet) in his own practice. This was soon found to be impracticable, and for three reasons: First, to secure and deliver regularly to the patients, scattered over a radius of at least two hundred miles, spleens in a state so fresh as to assure palatability is impossible. Second, to educate the patients so well that one can be certain that such spleens are eaten regularly is out of the question. Third, a



FIG. 3

Case 2 (P. B. 15434)

Above, before treatment. Below, after treatment.



supply of spleens is not available, as only by the purchase of futures can demand for this splenic extract be supplied.

Some other means of administration of the spleen had to be worked out, and it occurred to the writer that an extract of spleen might be made and used. This has been done.

#### METHOD OF PREPARATION

The spleens are purchased in large quantities, at the rate of about five thousand pounds a month at present, and are shipped frozen. After they are thawed out, the spleens are extracted with water, the coagulable proteins and fibers removed, and the aqueous fraction evaporated to a paste *in vacuo*. The consistency of this paste is that of thick condensed soup. One ounce of this aqueous extract (designated as S.V. 2) represents the water-soluble substances from approximately one pound of raw spleen. The preliminary biochemical analysis of this aqueous extract (S.V. 2) is found in Table I.

In addition to the aqueous extract (S.V. 2) other preparations have been made and tried,—*i.e.*, dried whole spleens (S.V. 1), and the dried residue (S.V. 3) remaining after the aqueous extract (S.V. 2) had been removed. A later paper will probably describe this work. Suffice it to say that no better results have been gotten from the dried whole spleen (S.V. 1) than from the aqueous extract (S.V. 2). The use of the dried

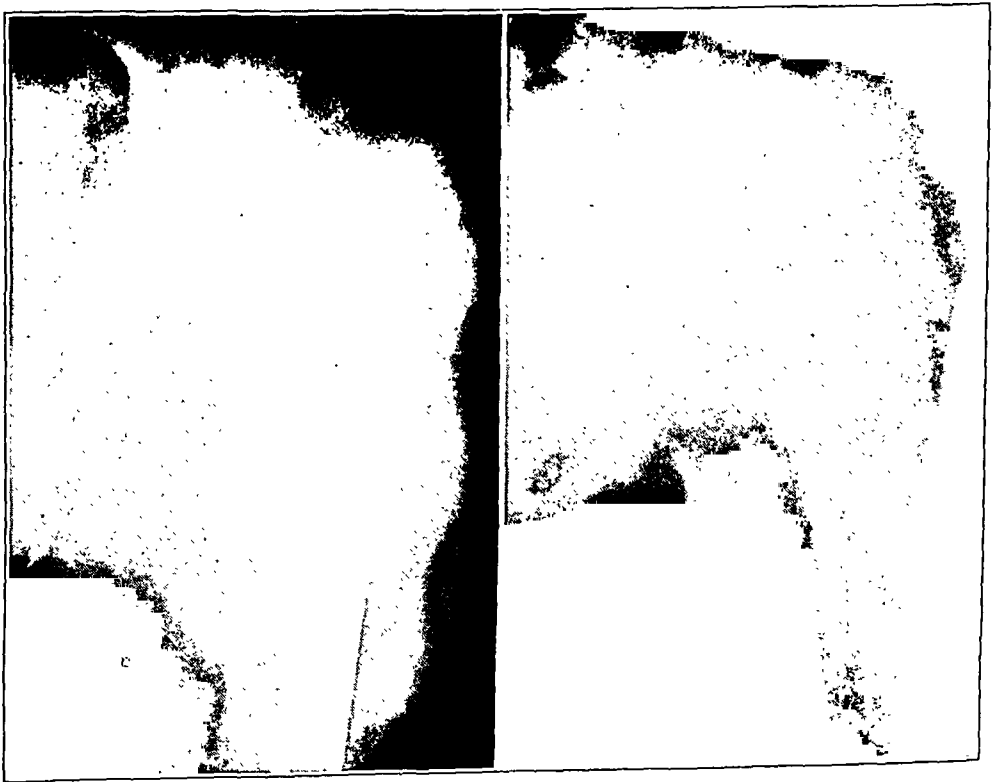


FIG. 4.

Case 3 (L. E. C. 14078)

Left, before treatment. Right, after treatment.

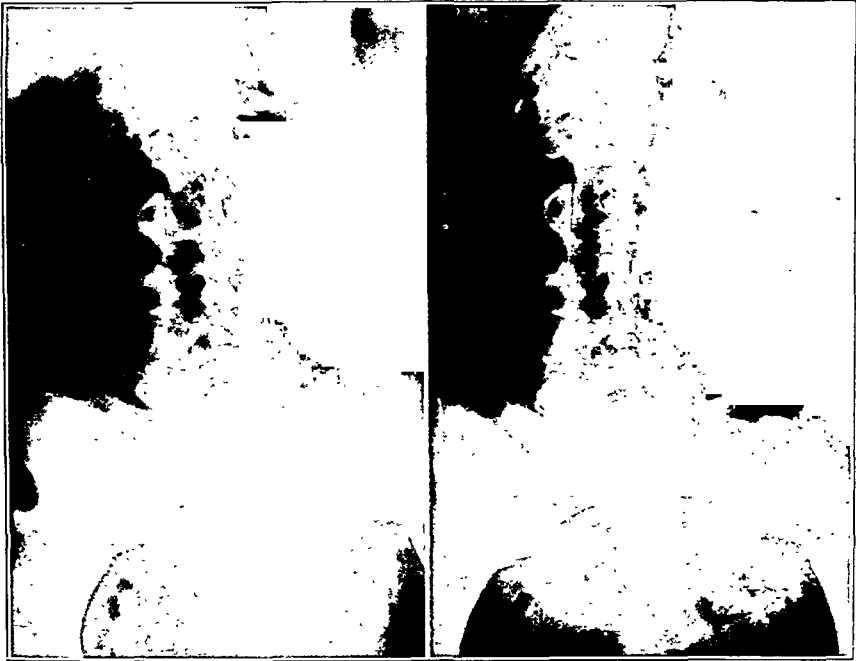


FIG. 5  
Case 4 (M. F. 14778)  
Left, before treatment. Right, after treatment.

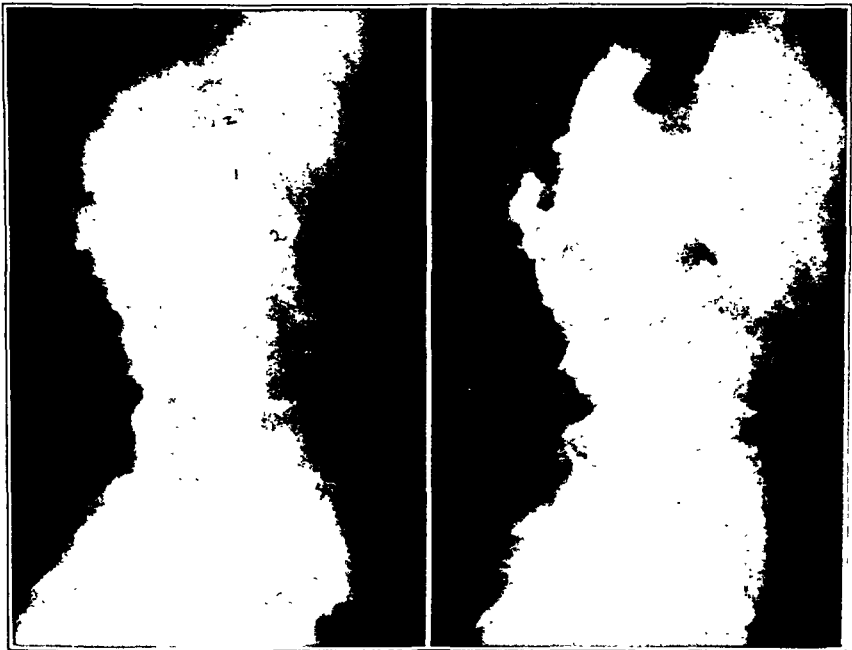


FIG. 6  
Case 4 (M. F. 14778)  
Left, before treatment. Right, after treatment.

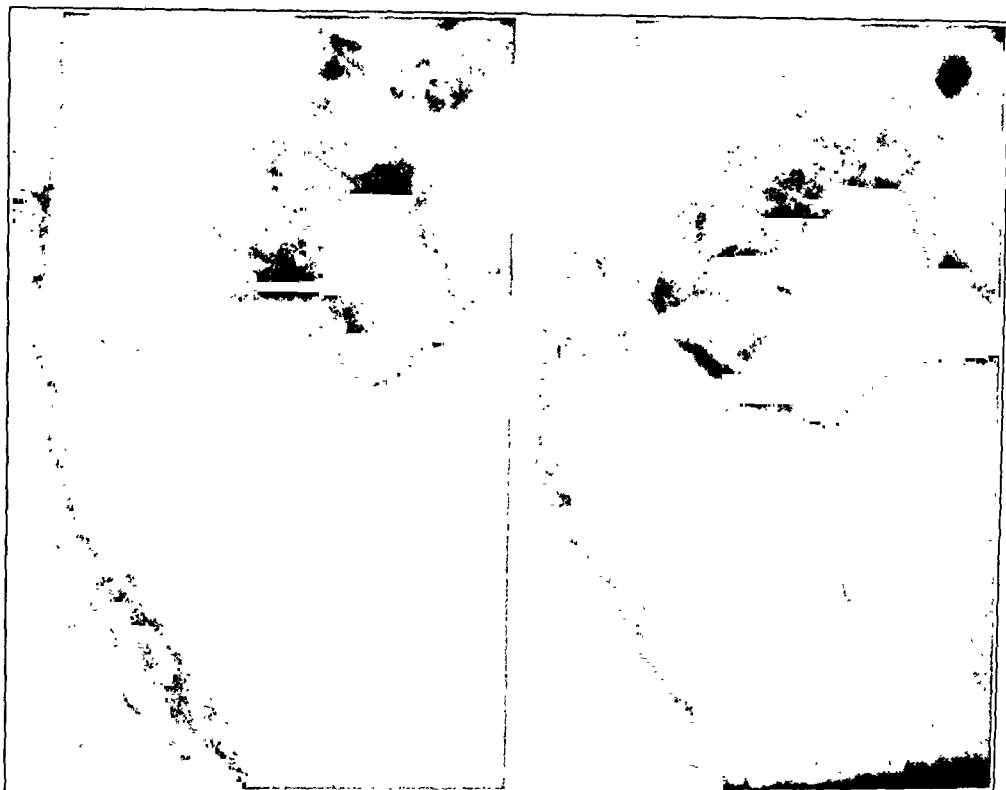


FIG. 7

Case 5 (P. F. 13386)

Left, before treatment. Right, after treatment.



FIG. 8

Case 5 (P. F. 13386)

Left, before treatment. Right, after treatment.

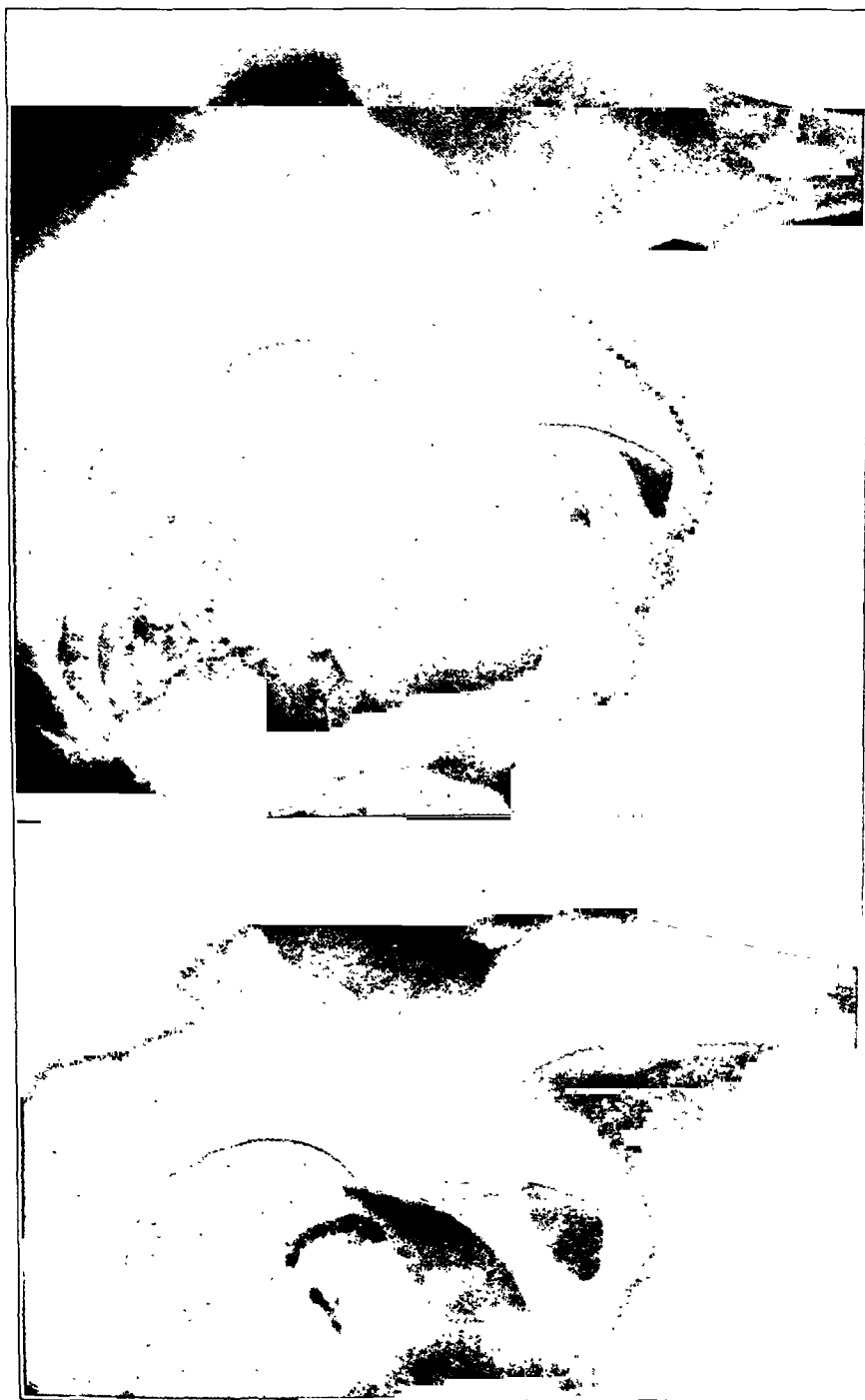


FIG. 9

CASE 6 (V. F. 16248)

Left, before treatment. Right, after treatment.

residue (S.V. 3) has not given enough encouragement to justify its continuance. The above leads to the belief that all or most of the active principle is to be found in the aqueous extract (S.V. 2), and the present paper deals with results obtained from this.

#### METHOD OF ADMINISTRATION

The aqueous extract of spleen (S.V. 2) is administered orally. The usual dosage is as follows:

The patient is given a teaspoonful three times a day for a week, or until it is found that he can and will tolerate the material. After that a tablespoonful is given three times a day. This dosage contains the active principle from one and one-half pounds of raw spleen. (Otto Fliegel administered only one and a half to three and a half ounces daily.) The dosage has not been varied, as very small children do not seem to have shown any ill effects and the dose seemed large enough for adults. Later it is expected that some quantitative work on this phase will be done.

The extract (S.V. 2) is best given in a sandwich, as hot bouillon, in tomato or orange juice, or as gravy. The use in gravy is probably the

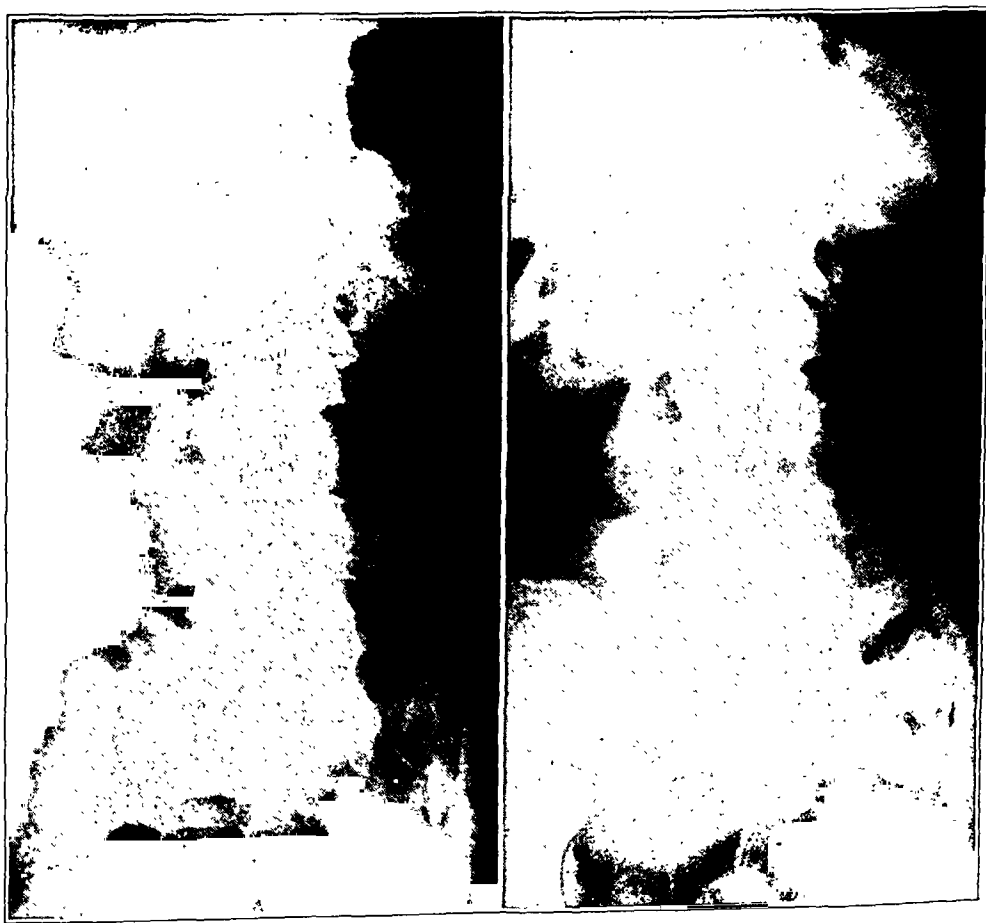


FIG. 10

Case 7 (R. H. 12244)

Left, before treatment. Right, after treatment.

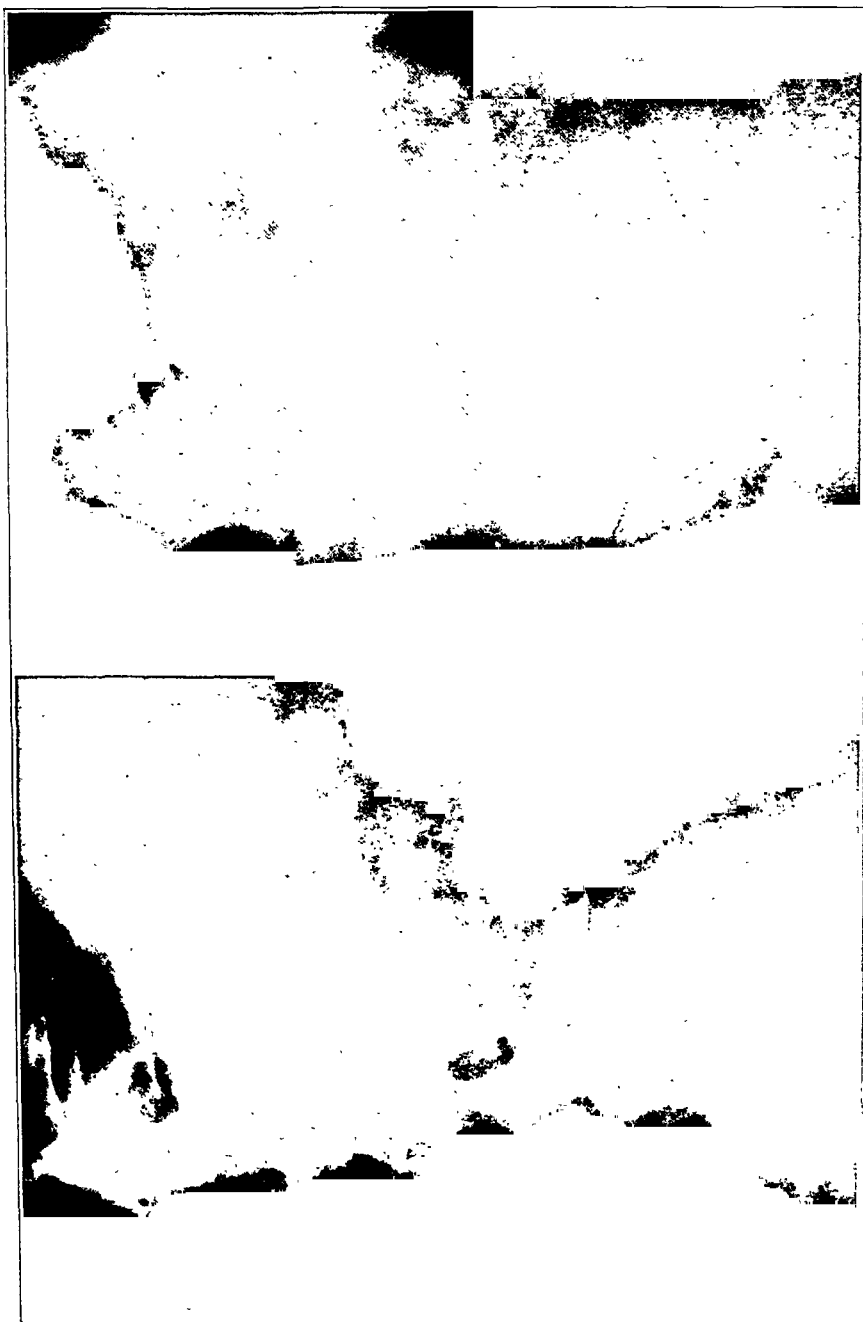


FIG. 11  
Case 7 (R. II. 12214)  
Left, before treatment. Right, after treatment.

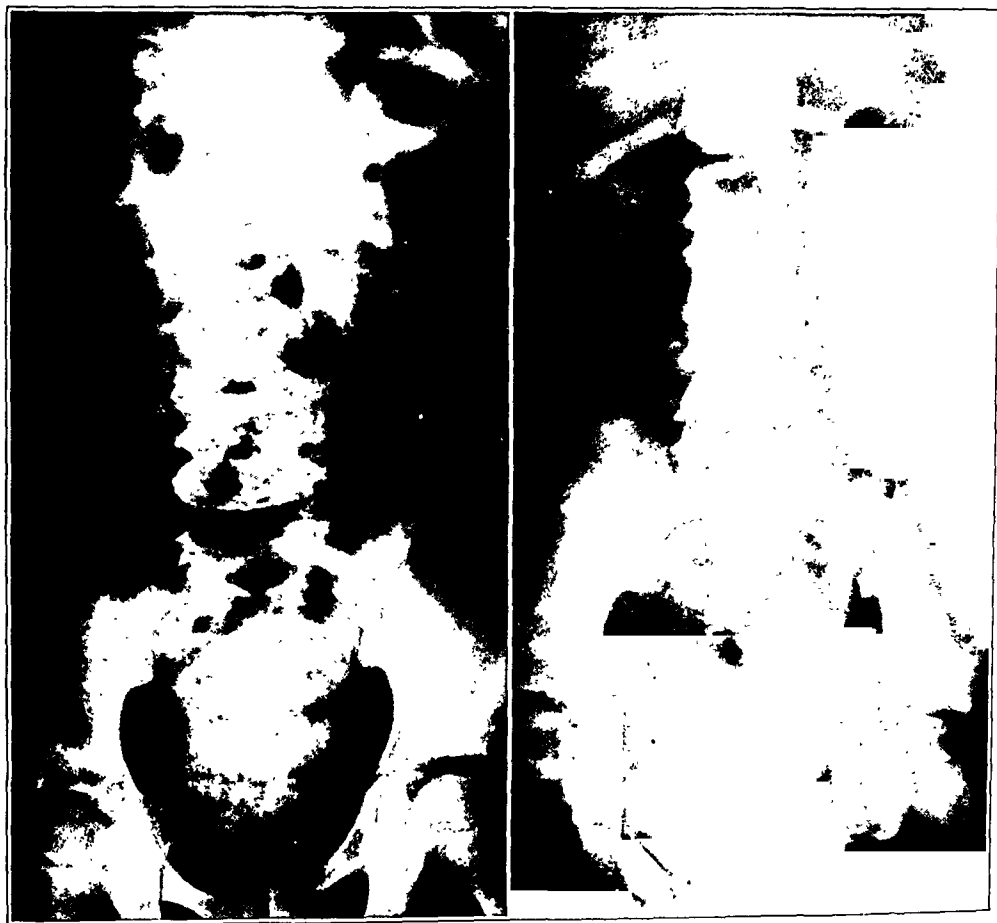


FIG. 12

Case 8 (R. H. 7468)

Left, before treatment. Right, after treatment.



FIG. 13

Case 9 (T. K. 14590)

Left, before treatment. Right, after treatment.

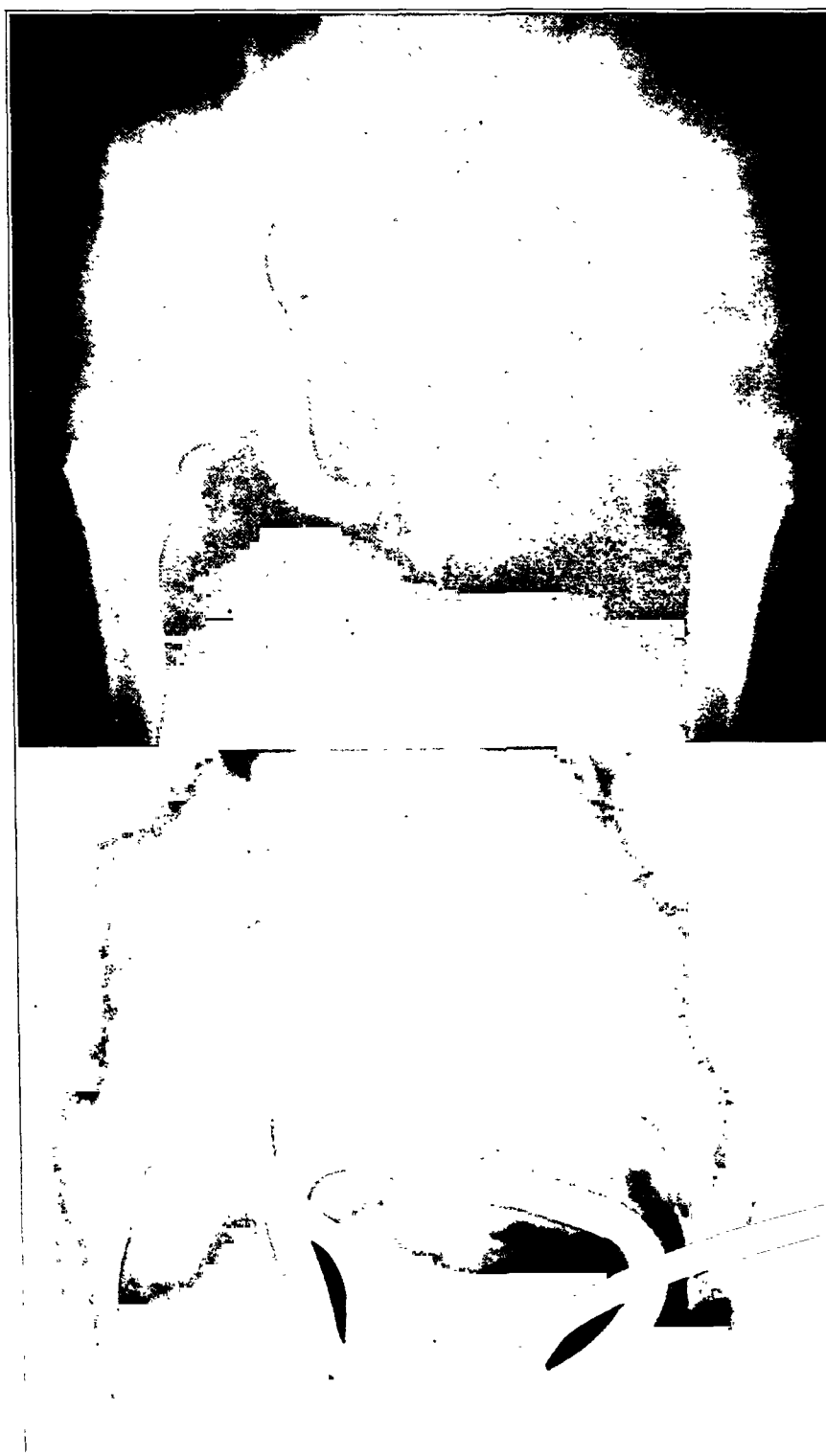


FIG. 14

Case 10 (R. McF. 17241)

Above, before treatment. Below, after treatment.



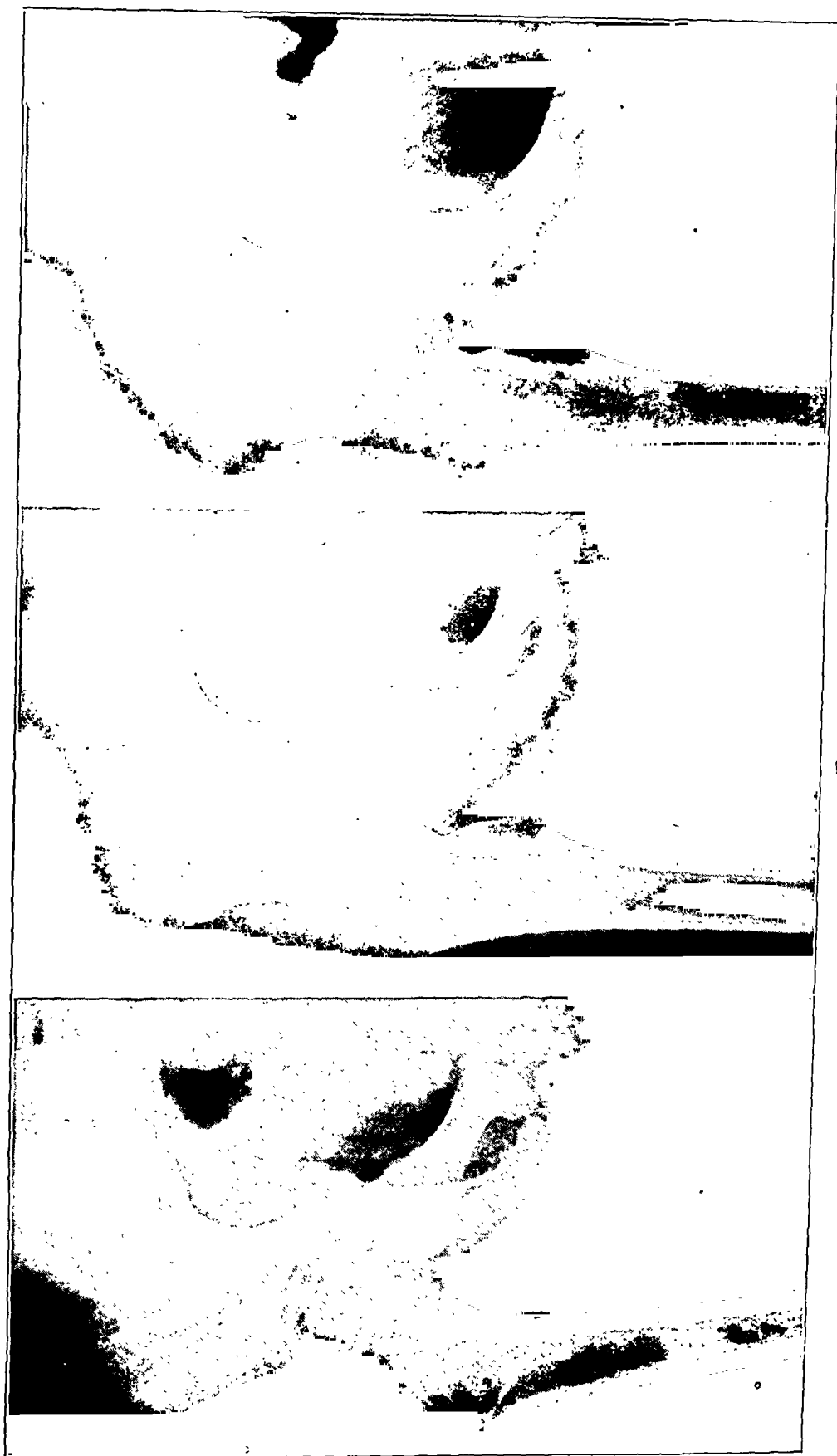


Fig. 15

Case 11 (C. P. 15300)  
Left, before treatment. Center, during treatment. Right, after treatment.

most practicable. The taste is pleasanter than the odor. The person preparing the material for administration is, therefore, instructed not to let the patient smell it. A few patients have been troubled by vomiting. This has usually accompanied the actual ingestion of the extract (S.V. 2), but, in a small number of cases, has followed in one-half to one hour where actual ingestion has been accomplished without unpleasantness. The successful administration has been gained eventually in all these patients by reducing the amount or changing the vehicle for a while. No single patient has been found unable eventually to tolerate the diet. (The dietary phase also is being worked on at this time.)

The first cases were put upon the aqueous extract (S.V. 2) February 16, 1931, and the administration of the material has been continued without interruption except during short intervals due to various conditions,—*i.e.*, trouble in distribution of product, intervening acute illness, social problems, at times actual inability to secure spleens, etc.

These cases will be kept upon the material continuously so long as they improve or so long as lack of improvement can be explained. A series of cases will soon be started upon periods of interval administration.

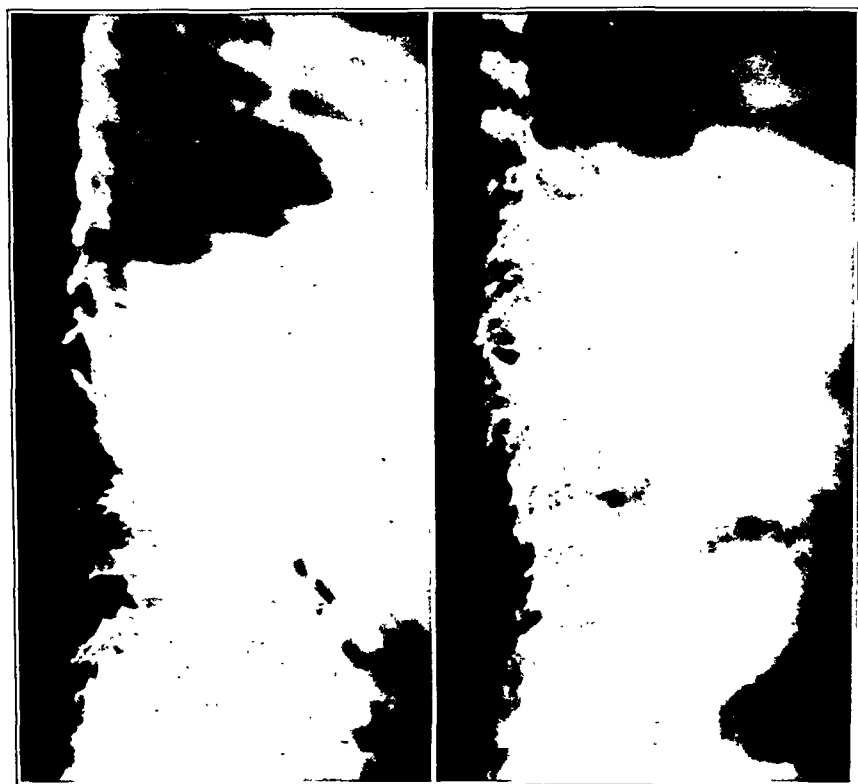


FIG. 16

Case 12 (D. F. 15755)

Left, before treatment. Right, after treatment.

This has not been done before because of a desire to get as much material as possible for the first paper.

#### GENERAL STATEMENT

At the present time the writer has on the splenic extract treatment (s.e.t.) over eighty cases in which it is thought a diagnosis of bone and joint tuberculosis can be safely made. In the present paper the results of splenic extract treatment (s.e.t.) of seventeen cases are considered. These seventeen cases were available when the first supply of aqueous extract (S.V. 2) was delivered. As this first supply was naturally limited in production, these cases were specially chosen to use the extract; they were chosen either because *they had not done well by treatment up until that time* (February 16, 1931) or because *they were so severely involved that improvement could be quickly ascertained*. As production of the aqueous extract (S.V. 2) has been increased, the number of patients to whom it is administered has been increased, so that at this time (May 1, 1932) all the writer's cases of bone and joint tuberculosis are receiving it.

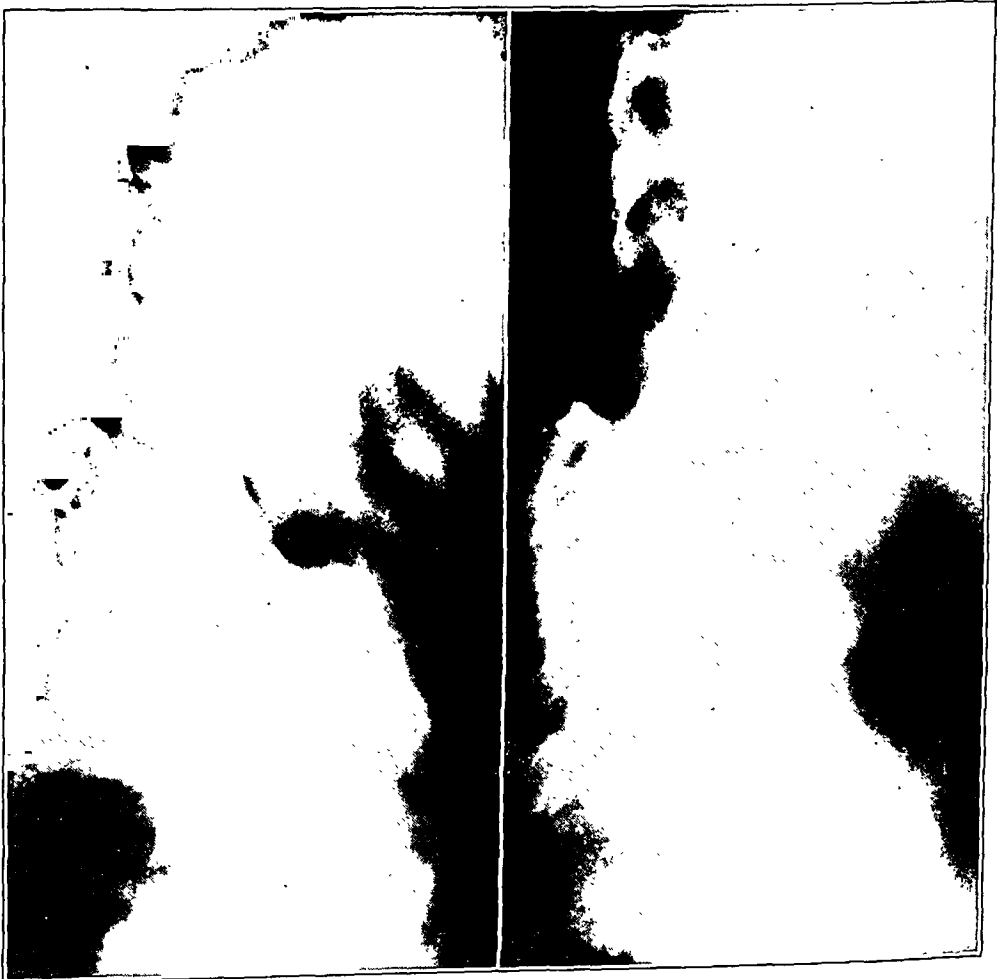


FIG. 17

Case 13 (H. R. 9682)

Left, before treatment. Right, after treatment.

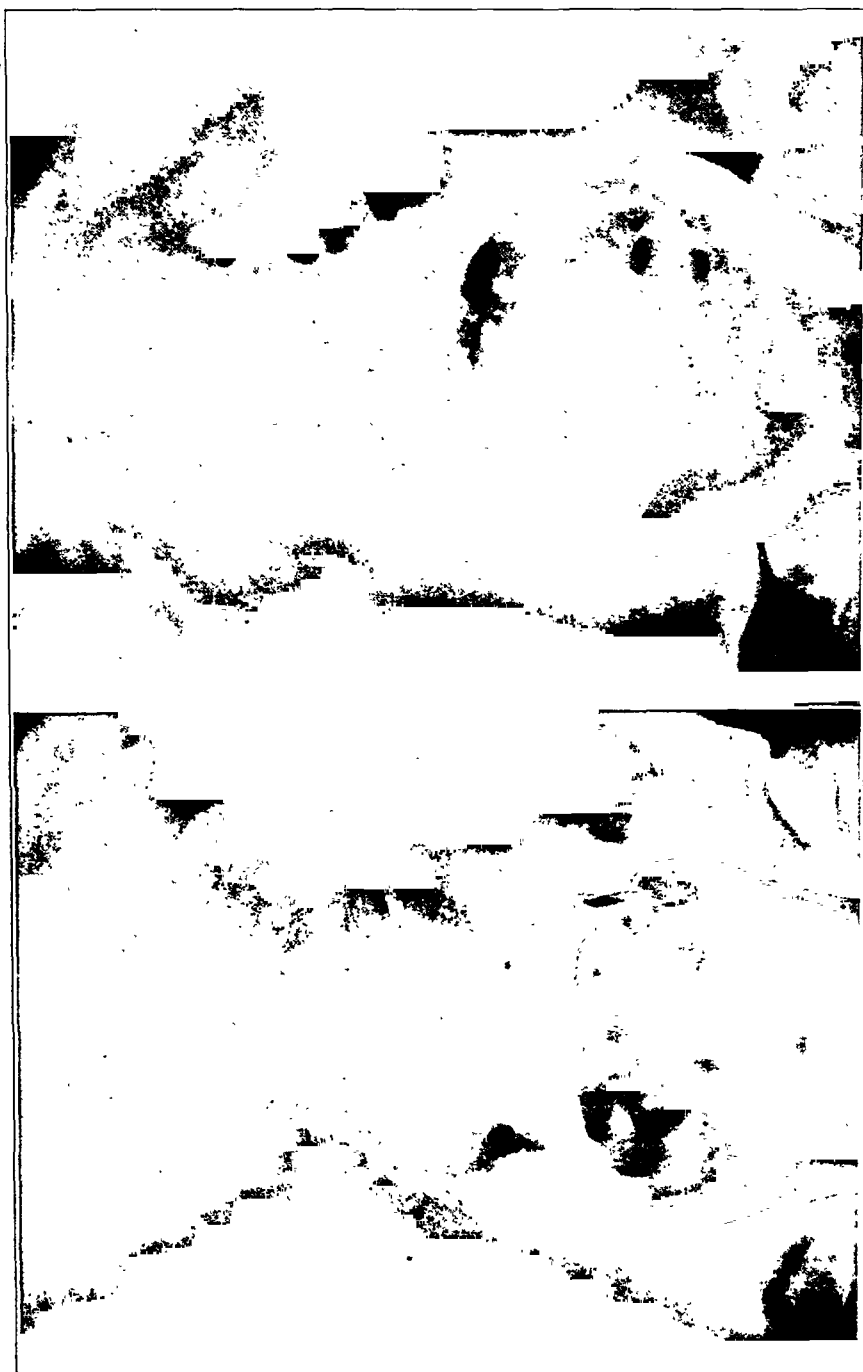


FIG. 18

Case 13 (H. R. 9682)  
Left, before treatment. Right, after treatment.

TABLE I  
PRELIMINARY BIOCHEMICAL ANALYSIS OF SPLENIC EXTRACT

	<i>Per Cent. of Wet Weight</i>	<i>Nitrogen, as Per Cent. of Total Nitrogen</i>	<i>Per Cent. of Ash</i>
Moisture (95° C.).....	47.20		
Ash.....	9.94		
Chlorides, as NaCl.....	2.38		24.00
Phosphorus, as P <sub>2</sub> O <sub>5</sub> .....	2.52		25.40
Calcium, as CaO.....	0.06		0.60
Total Nitrogen.....	6.65		
Water-Insoluble Protein.....	17.80	42.90	
Coagulable Protein.....	0.73	1.76	
Proteose.....	1.59	3.82	
Nitrogen as Ammonia, Peptides and Extractives.....		51.50	
Ether extract (crude fat, etc.), not over..	0.40		
Carbohydrates.....	Too low for quantitative estimation.		

One ounce of splenic extract yields about thirty-two calories

Experience with the splenic extract treatment, using the aqueous extract of spleen (S.V. 2), has been so encouraging that the writer wishes to describe the results in the seventeen cases which have been under treatment now for over a year, *expressing only the hope* that there may have been developed an adjuvant which will materially lessen the acuteness of this disease, lessen its duration, and possibly help prevent metastasis and recurrence. It will take longer to decide whether the type of healing is to be altered or not, and it will be necessary to reserve for a future paper the explanation of the improvement. The work was undertaken on the basis of treatment of bone and joint tuberculosis. Such satisfactory deposition of calcium was found, that a supplementary series of cases has been started in osteomyelitis and ununited fractures. There is tangible evidence that the splenic extract treatment (s.e.t.) assists the healing of acute osteomyelitis (pyogenic) and is a valuable assistant in the treatment of chronic osteomyelitis (after sequestra, if present, have been removed). There is definite evidence that fractures which have shown very little or no callus formation in periods up to one year have become solid in six to eight weeks.

The secondary anaemias seem to improve.

And still the writer is, as a result of this mass of information, bewildered, for he does not feel that he can state at present whether the improvement comes from control of Koch's bacillus, whether it comes from the stimulation of the reparative processes of the bone itself (possibly through the synovial membrane, or the marrow, or both), whether it comes from the improvement in the blood composition, or whether it comes from the effect on other organs or tissues as a biochemical stimulant or hormone. The literature has been reviewed, and in so far as no article available has given a specific explanation for the improvement of bone or

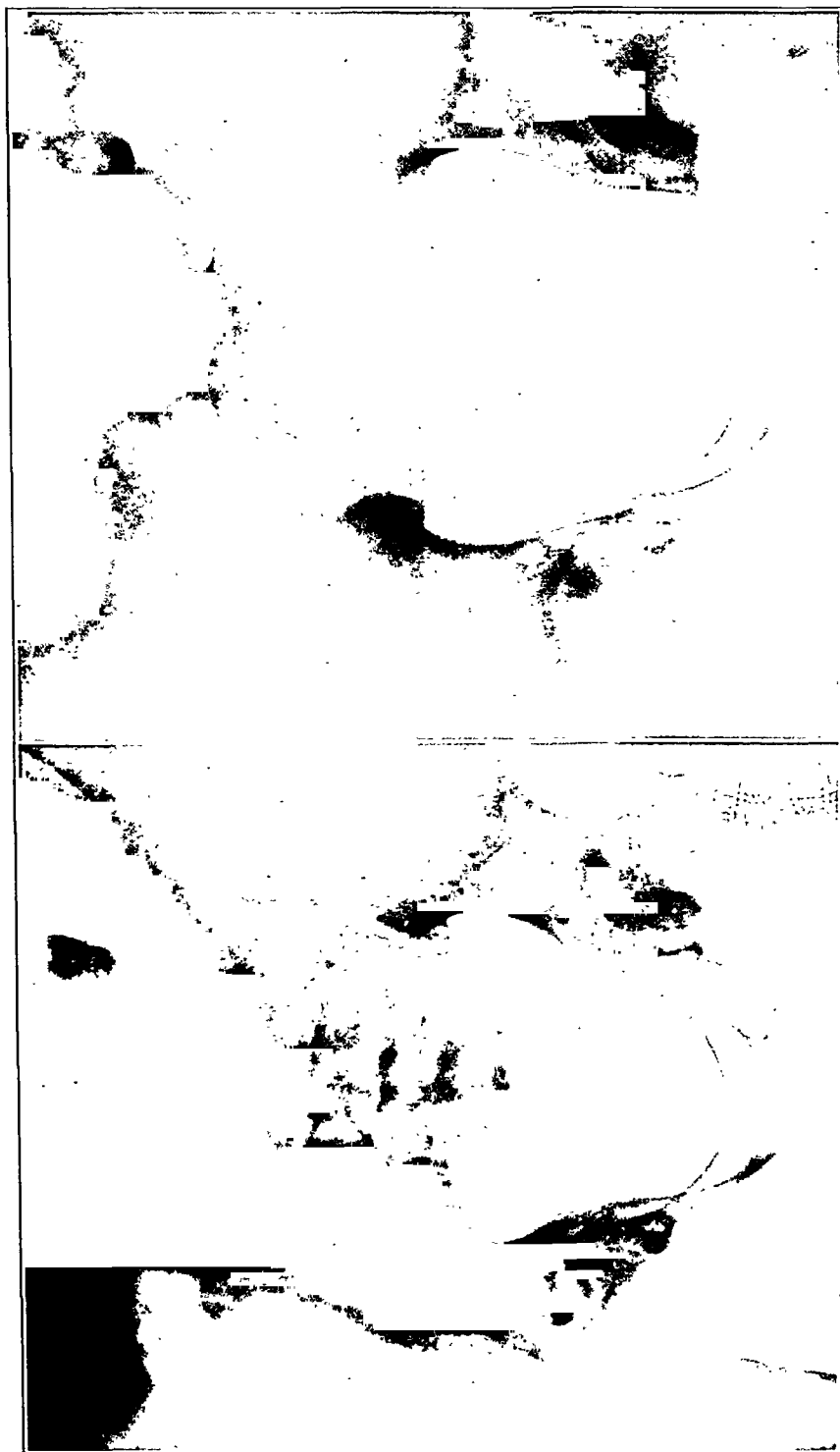


FIG. 19  
Case 14 (A. R. 15208)  
Left, before treatment. Right, after treatment.

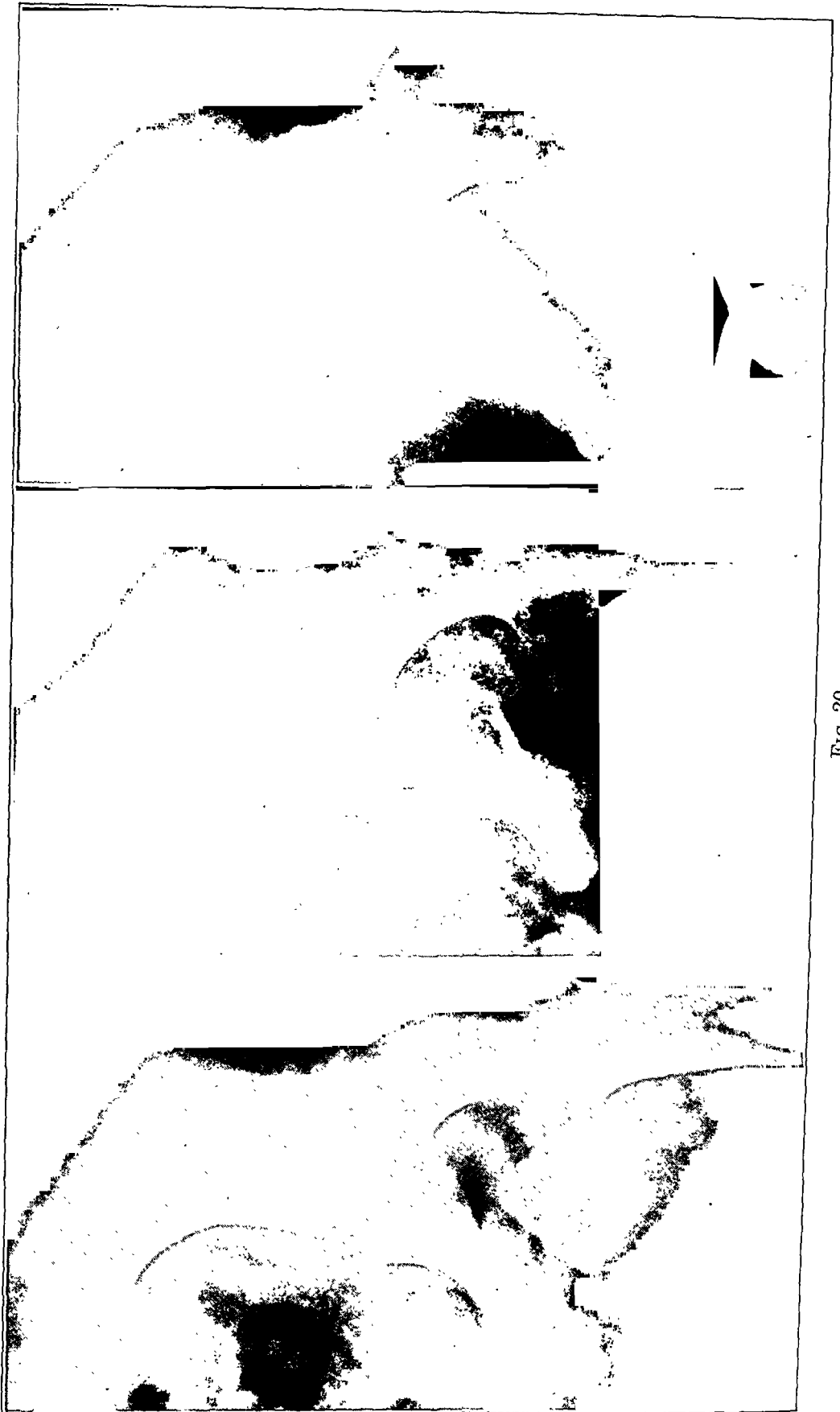


FIG. 20  
Case 15 (C. W. 14841)  
Left, before treatment

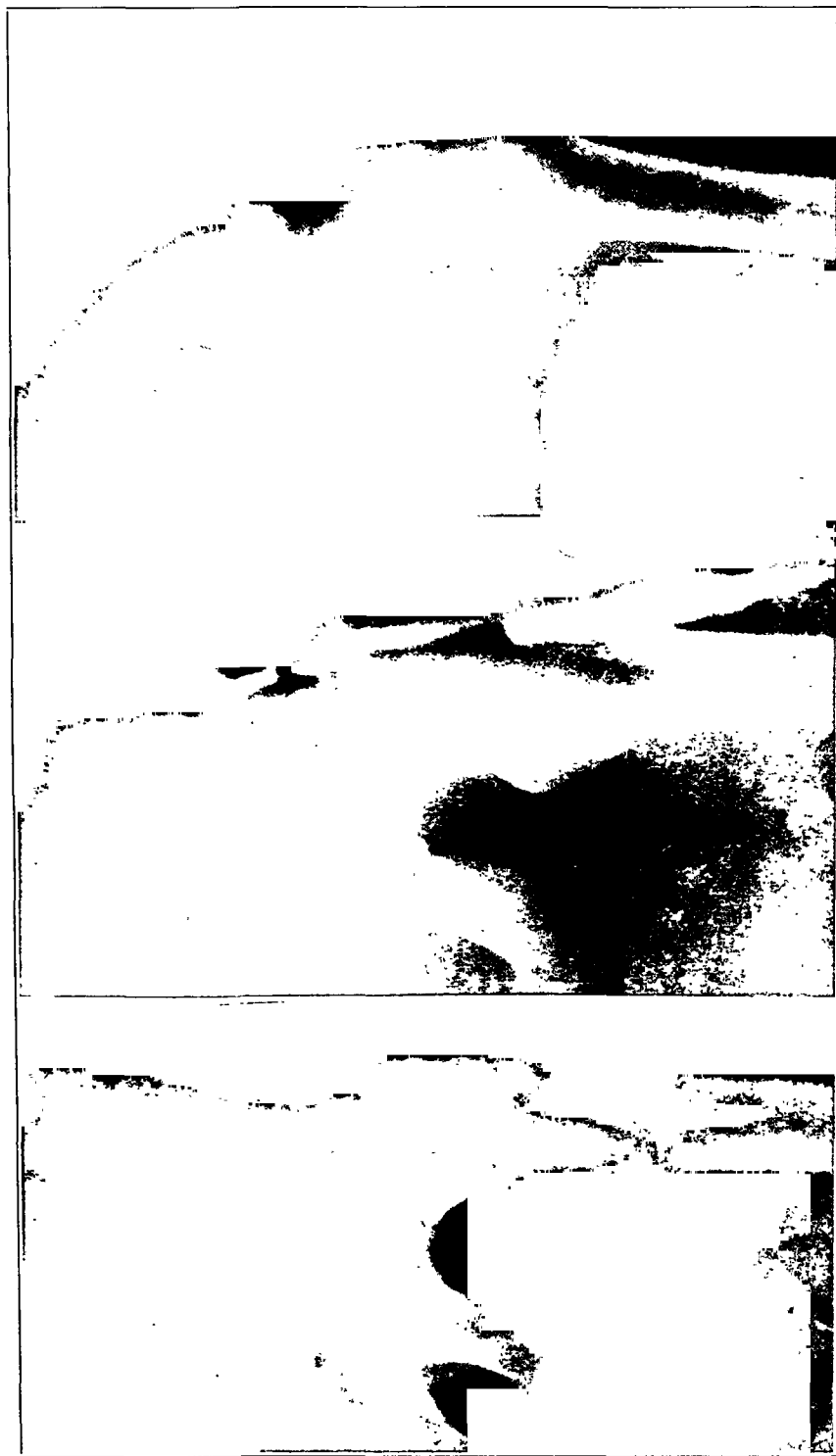


Fig. 21

Case 16 (C. W. 15239)

Left, before treatment. Center, during treatment. Right, after treatment.



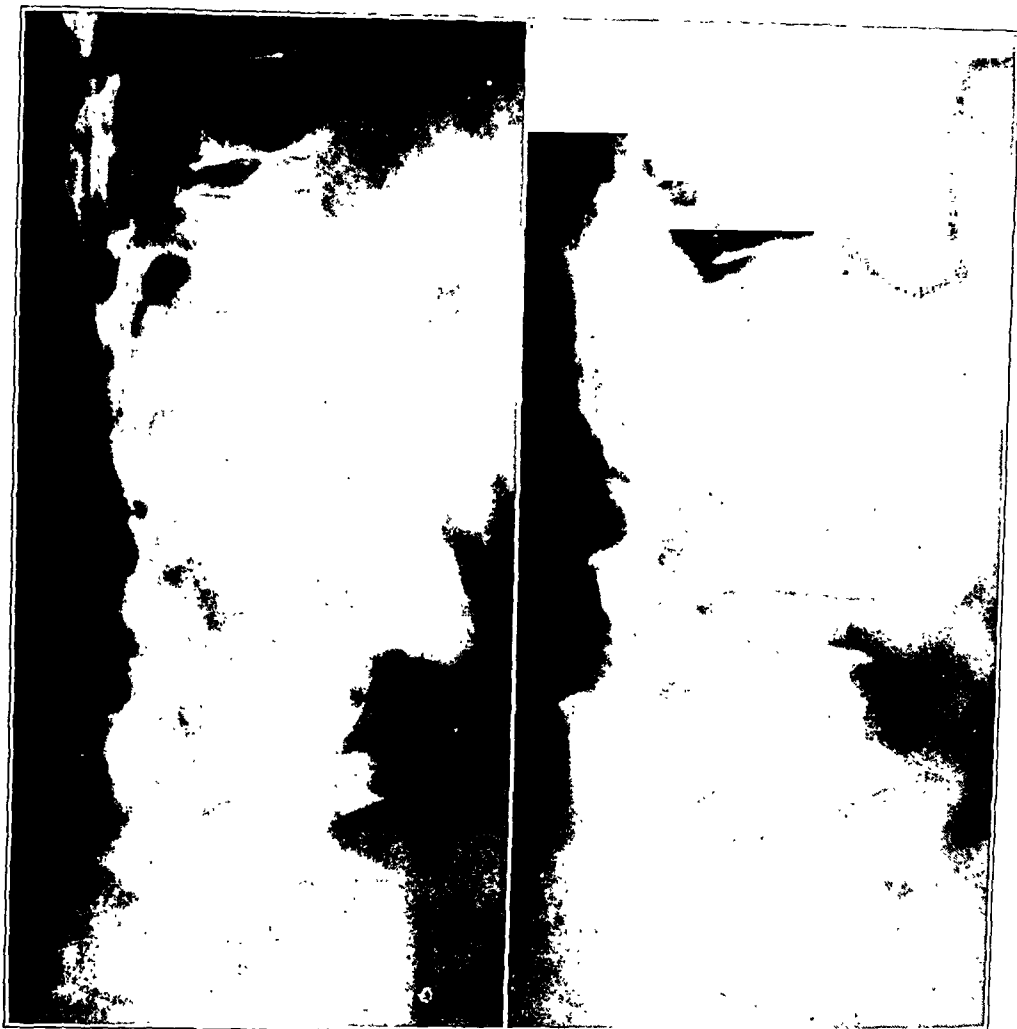


FIG. 22

Case 17 (C. W. 12489)

Left, before treatment. Right, after treatment.

joint conditions under the administration of spleen, these cases are presented without reference to these articles. (Those interested can easily find most of the information on the subject available at present in the work of Dr. Bayle who, in his article of 1931 and in a personal communication, shows that he is still actively working on the subject.)

#### OBSERVATIONS

As the cases are widely distributed in rural sections of the state, a complete accumulation of data at the beginning of the splenic extract treatment (s.e.t.) was not possible. It seemed best to go right ahead and start treatment and catch up the data later. Whether progress has been made to the satisfaction of everyone will have to be determined by each orthopaedic surgeon as to his own experience in a similar group of cases, under circumstances similar to those described previously in this paper. The observations here presented are being checked by others.

The writer has felt that the x-ray diagnosis was satisfactory in all of



FIG. 23

Case 17 (C. W. 12489)

Left, before treatment. Right, after treatment.

the cases except those of C.P. 15330 and C.W. 16239. In the case of C.P. 15330 the diagnosis was confirmed by pathological examination of the biopsy material. In the case of C.W. 15239 there was a pure culture of bacillus tuberculosis on potato. This was obtained from material from the patient's sinus. (Photographs of both of these patients are available.)

All these facts are brought out in Tables II, III, IV, and V.

#### SUMMARY

From the foregoing the writer draws the following conclusions:

1. The use of splenic extract in the diet of patients suffering with bone and joint tuberculosis has been found very beneficial, as improvement is noted in the febrile condition, the local reactions, the growth, the weight, the color, the appetite, the blood composition, the deformity, the complications, the roentgen picture, the activity permissible to the patients, and the dispensing with support.

TABLE II  
SUMMARY OF CASES

<i>Case</i>	<i>No.</i>	<i>Age</i>	<i>Duration of Disease when S.E.T. Began</i>	<i>Complications</i>	<i>Location</i>	<i>Duration of S.E.T.</i>	<i>Duration of Treatment Before Starting S.E.T.</i>
1. F. B.	13092	8 years	2 years	Paralysis of both lower extremities	Spine	1 year, 2 mos.	1 year
2. P. B.	15434	24 years	3 years, 6 mos.	Draining sinus	Sacro-iliac joint	1 year, 2 mos.	1 year
3. L. C.	14078	15 years	Unknown		Hip	1 year, 2 mos.	8 months
4. M. F.	14778	50 years	2 years		Spine	1 year, 2 mos.	4 months
5. P. F.	13386	40 years	10 years		Spine	1 year, 2 mos.	1 year
6. V. F.	16248	10 years	4 months		Hip	1 year, 2 mos.	None
7. R. H.	12244	63 years	Unknown	Paralysis of both lower extremities	Spine	1 year, 2 mos.	1 year, 1 mo.
8. R. H.	7468	10 years	5 years		Spine	1 year, 2 mos.	4 years
9. T. K.	14590	15 years	8 years		Spine	1 year, 2 mos.	6 months
10. R. M.	17241	7 years	3 months		Hip	1 year, 2 mos.	None
11. C. P.	15300	7 years	1 year		Ilium	1 year, 2 mos.	6 months
12. D. P.	15755	5 years	2 months	Paralysis of both lower extremities	Spine	1 year, 2 mos.	None
13. H. R.	9682	10 years	1 month		Spine	1 year, 2 mos.	3 years
14. A. R.	15208	17 years	Unknown	Paralysis of both lower extremities	Spine	1 year, 2 mos.	None
15. C. W.	14841	12 years	6 months		Hip	1 year, 2 mos.	3 months
16. C. W.	15239	41 years	3 years	Draining sinus	Femur	1 year, 2 mos.	None
17. C. W.	12489	39 years	2 years	Paralysis of both lower extremities	Spine	1 year, 2 mos.	1 year, 6 mos.

<i>Case</i>	<i>No.</i>	<i>Treatment Previous to S.E.T.</i>	<i>Promosis when S.E.T. Started</i>	<i>Treatment Supplementing S.E.T.</i>
1. F. B.	13092	Support and recumbency	Paralysis slow in clearing up	Support and recumbency. Recumbency has been unnecessary for several months now.
2. P. B.	15434	Incision of abscess	No change in sinus	None.
3. L. C.	14078	Support and recumbency	Unimproved	Support. This has been unnecessary for several months.
4. M. F.	14778	Support	Unimproved	Support.
5. P. F.	13386	Support	Improving	Support.
6. V. F.	16248			Support and recumbency. Recumbency has been unnecessary for some time.
7. R. H.	12244	Support and recumbency	Still paralyzed	Support and recumbency. Recumbency has been unnecessary for six months.
8. R. H.	7468	Support and recumbency	Improvement very slow	Support and recumbency. Recumbency has been unnecessary for several months.
9. T. K.	14590	Support	No improvement	Support.
10. R. M.	17241			Support and recumbency.
11. C. P.	15300	Support and recumbency	No improvement	Support and recumbency. Recumbency has been unnecessary for some time.
12. D. P.	15755			Support and recumbency.
13. H. R.	9682	Support and recumbency	Improvement slow	Support and recumbency. Recumbency has been unnecessary for some time.
14. A. R.	15208			Support and recumbency. Recumbency has been unnecessary for four months.
15. C. W.	14841	Support and recumbency	No improvement	Support and recumbency. Recumbency has been unnecessary for several months.
16. C. W.	15239			None.
17. C. W.	12489	Support and recumbency	Improvement slow	Support and recumbency. Recumbency has been unnecessary for several months.

TABLE III  
RESULTS OF TREATMENT

Case	No.	Tem- perature (Degrees)	Height (Inches)	Weight	Weight Va- riation Since S.E.T. Started	Ideal Weight	Color	Appetite	Blood * Composition	Pain
1. F. B.	13092	98.6	42	45	Gain	39	Improved	Improved	Improved	Less
2. P. B.	15434	98.6	68	160	Gain	154	Improved	Improved	Improved	Less
3. L. C.	14078	98.6	59	88	Gain	90	Improved	Improved	Improved	Less
4. M. F.	14778	98.6	60	125	Gain	116	Improved	Improved	Improved	Less
5. P. F.	13386	98.6	60	140	Gain	118	Improved	Improved	Improved	Less
6. V. F.	16248	98.6	60	95	Gain	91	Improved	Improved	Improved	Less
7. R. H.	12244	98.6	60	120	Gain	116	Improved	Improved	Improved	Less
8. R. H.	7468	98.6	47	56	Gain	50	Improved	Improved	Improved	Less
9. T. K.	14590	98.6	56	82	Gain	80	Improved	Improved	Improved	Less
10. R. M.	17241	98.6	41	33	Gain	38	Worse	Improved	Improved	Less
11. C. P.	15300	98.6	40	35	Gain	36	Improved	Improved	Improved	Less
12. D. P.	15755	98.6	38	20	Gain	33	Improved	Poor	Improved	Less
13. H. R.	9682	98.6	45	52	Gain	46	Improved	Improved	Improved	Less
14. A. R.	15208	98.6	61	100	Gain	106	Improved	Improved	Improved	Less
15. C. W.	14841	98.6	50	65	Gain	58	Improved	Improved	Improved	Less
16. C. W.	15239	98.6	70	150	Gain	162	Same	Improved	Improved	Less
17. C. W.	12489	98.6	60	95	Gain	119	Improved	Improved	Improved	Less

\* See Tables IV and V.

<i>Case</i>	<i>No.</i>	<i>Progress of Complications Other than Abscess</i>	<i>Clinical Progress of Abscess † if Present When S.E.T. Started</i>	<i>Progress of Gross Deformity</i>	<i>Changes in Tu- berculous Abscess (Roentgenographic)</i>
1. F. B.	13092	Paralysis disappeared		Lateral angulation less	No abscess
2. P. B.	15434	Sinus closed	Abscess disappeared	No deformity	No abscess
3. L. C.	14078			Slight increase	No abscess
4. M. F.	14778			Very slight deformity	No abscess
5. P. F.	13386			Kyphosis slightly in- creased	No abscess
6. V. F.	16248			No deformity	No abscess
7. R. H.	12244	Paralysis disappeared		No increase	No abscess
8. R. H.	7468		Abscess not clinically demonstrable	Lateral deformity less	Abscess about the same
9. T. K.	14590			Deformity same	No abscess
10. R. M.	17241		Abscess improved	Deformity has increased	No abscess
11. C. P.	15300		Abscess disappeared	Deformity less	No abscess
12. D. P.	15755	Paralysis disappeared	Abscess has not improved	Deformity same	No abscess
13. H. R.	9682			Deformity less	No abscess
14. A. R.	15208	Paralysis disappeared	Abscess not clinically demonstrable	Deformity less	Abscess same
15. C. W.	14841			No increase	No abscess
16. C. W.	15239	Sinus closed	Abscess disappeared		No abscess
17. C. W.	12489	Paralysis disappeared		Deformity less	No abscess

† No case, in which a.e.t. has been started at beginning of disease or in which no abscess was present when a.e.t. was started, has so far developed an abscess.

TABLE III (continued)  
RESULTS OF TREATMENT (continued)

Case	No.	Calcification of Lesion (Roentgenographic)	Detail of Lesion (Roentgenographic)	Progress of Destruction (Roentgenographic)	Evidences of Fusion (Roentgenographic)	Activity of Patient at This Time
1. F. B.	13092	Increased	Improved	Less	Actual fusion seen	Goes to school.
2. P. B.	15434	Increased	Improved	Less	Actual fusion	Works as waiter.
3. L. C.	14078	Increased	Improved	Less	Actual fusion	Helps on farm.
4. M. F.	14778	Very little increase	Improved	Considerable absorption between twelfth dorsal and first lumbar	Actual fusion between first and second lumbar	Ambulatory. No work.
5. P. F.	13386	Marked increase	Improved		Actual fusion	Ambulatory. No work.
6. V. F.	16248	Increased	Improved	Joint space narrower	A little bony fusion	Goes to school.
7. R. H.	12244	Considerable increase	Improved	No more destruction	Actual fusion	Ambulatory. No work
8. R. H.	7468	Increased	Improved	No increase	Not visible	Goes to school.
9. T. K.	14590	Marked increase	Improved	No more destruction	Actual fusion	Goes to school.
10. R. M.	17241	Less	Unimproved	Joint space obliterated	Actual fusion	Recumbent.
11. C. P.	15300	Increased	Improved	Less	No fusion	Ambulatory.
12. D. P.	15755	Increased	Same	Increased	Fusion	Guarded activity.
13. H. R.	9682	Increased	Improved	No further destruction	Fusion	Recumbent.
14. A. R.	15208	Increased	Improved	No more destruction	Actual fusion	Goes to school.
15. C. W.	14841	Increased	Improved	No more destruction	Actual fusion	Leads normal life. Goes to school.
16. C. W.	15239	Increased	Improved	Small sequestrum present	Actual fusion	Ambulatory. Guarded activity.
17. C. W.	12489	Increased	Improved	No more destruction	Actual fusion	Ambulatory. Not allowed to work. Ambulatory. Does some of housework.

TABLE IV  
ANALYSIS OF SCHILLING DIFFERENTIAL BLOOD COUNT

Case	No.	Basophils	Eosinophils	Myelocytes	Juvenile Slab	Segmented Lymphocytes	Monocytes	Shift to		Stage of Infection		Severity of Infection	Resistance	Progress	Lymphocyte-Monocyte Ratio	
								Left	Infection							
1.	F. B.	13092	0	6	0	2	8	55	25	4	15	Chronic	Slight	Good	Healing	25:4
2.	P. B.	15131	0	2	0	0	24	37	35	2	39.9	Chronic	Moderate	Low	Healing	35:2
3.	L. C.	14078	0	5	0	2	9	53	27	4	17.2	Chronic	Slight	Good	Healing	27:4
4.	M. F.	14778	0	0	0	4	26	32	30	8	65.9	Acute	Severe	Good	Satisfactory	30:8
5.	P. F.	13386	0	0	0	2	25	27	29	17	50	Acute	Severe	Good	Not sufficient healing	29:17
6.	V. F.	16218	0	0	3	1	25	53	12	6	35.4	Chronic	Moderate	Good	Healing not satisfactory	12:6
7.	R. H.	12214	0	0	0	1	18	37	37	7	33.9	Acute	Moderate	Good	Healing	37:7
8.	R. H.	7408	1	1	0	0	7	33	57	1	17.5	Chronic	Slight	Poor	Healing	57:1
9.	T. K.	14590	0	2	0	0	11	32	43	12	25.5	Chronic	Moderate	Good	Healing	43:12
10.	R. M.	17211	1	2	0	6	14	33	29	15	64.6	Acute	Moderate	Good	Unsatisfactory	29:15
11.	C. P.	15300	0	0	3	1	28	50	13	5	37.9	Chronic	Moderate	Good	Healing not satisfactory	13:5
12.	D. P.	15755	0	1	0	1	6	70	18	4	9.0	Chronic	Slight	Good	Healing	18:4
13.	H. R.	9082	0	8	0	1	3	17	69	3	19.0	Chronic	Slight	Normal	Healed	69:3
14.	A. R.	15208	0	1	1	2	12	52	28	4	22.0	Chronic	Moderate	Good	Healing	28:4
15.	C. W.	11811	3	5	2	4	3	63	16	4	12.5	Chronic	Slight	Good	Healing	16:4
16.	C. W.	15239	0	1	0	0	13	65	18	3	16.7	Chronic	Slight	Good	Healing	18:3
17.	C. W.	12189	0	0	0	4	30	42	15	9	44.7	Chronic	Severe	Good	Healing unsatisfactory	15:9



TABLE V  
ANALYSIS OF BLOOD COMPOSITION

Case	No.	Red Blood Cells (per cubic millimeter)	Hemoglobin (per cent.)	White Blood Cells (per cubic millimeter)
1. F. B.	13092	4,360,000	88	9,000
2. P. B.	15434	4,024,000	80	6,400
3. L. C.	14078	4,700,000	90	6,500
4. M. F.	14778	3,184,000	62	5,000
5. P. F.	13386	4,616,000	80	5,000
6. V. F.	16248	4,700,000	88	6,800
7. R. H.	12244	3,072,000	66	7,400
8. R. H.	7468	4,190,000	86	7,200
9. T. K.	14590	4,184,000	62	8,200
10. R. M.	17241	4,400,000	80	6,500
11. C. P.	15300	4,500,000	70	7,600
12. D. P.	15755	5,000,000	90	10,500
13. H. R.	9682	4,330,000	87	8,760
14. A. R.	15208	4,790,000	96	7,920
15. C. W.	14841	4,800,000	90	6,200
16. C. W.	15239	4,640,000	90	17,250
17. C. W.	12489	4,470,000	83	14,200

2. Improvement from splenic extract treatment probably will be more apparent to those who are unable to enforce a strict compliance with the accepted ideal treatment,—*i.e.*, support, recumbency, heliotherapy, proper feeding, and proper aeration.

3. The production of splenic extract is possible and the distribution is practicable.

4. It is possible to obtain the cooperation of patients in adopting the splenic extract diet, even of those in remote sections.

5. Splenic extract treatment has also produced improvement in osteomyelitis (acute and chronic) and in ununited fractures. This investigation is well under way.

6. Enough improvement has been shown in the blood composition to stimulate further study of this phase.

7. The writer cannot explain the improvement gained by the administration of splenic extract. Various explanations given so far may all be true, but these investigations lead to the belief that as yet there is no certainty as to which is the most important factor.

The author wishes to acknowledge the scientific assistance in this investigation given by Mr. C. Braxton Valentine, Chemical Director of the Valentine's Meat-Juice Company, and the extract of spleen used in these experiments which was supplied by this Company.

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# METHODS OF MEASURING THE PRESSURE OF THE INTER-VERTEBRAL DISC\*

BY CHARLES K. PETTER, M.D., OAK TERRACE, MINNESOTA

*Senior Resident Physician, Glen Lake Sanatorium*

In 1904 and 1911 Fick described the anatomy of the intervertebral disc; and prior to 1926 many reports are to be found of abnormalities, injuries, and other pathology. The extensive work of Schmorl regarding the anatomy, physiology and pathology of the disc has recently been published. Dr. Geist suggested the present study.

It is commonly known that on cross section of an intervertebral disc the cut surface bulges. The observations of others have led to the statement that, in addition to the superincumbent weight and ligamentous pull which act as an external force on each disc, there also exists an internal or expansive force. We have endeavored to measure if possible the magnitude of this internal force.

All observations have been made on spines of individuals dying of tuberculosis, at Glen Lake Sanatorium, and the autopsies were performed as soon after death as possible (average time, four hours after death).

Our first observation was that a "block" made up of two or more vertebral bodies and their intervening discs became appreciably longer when removed from the body (Fig. 1). This was determined by affixing

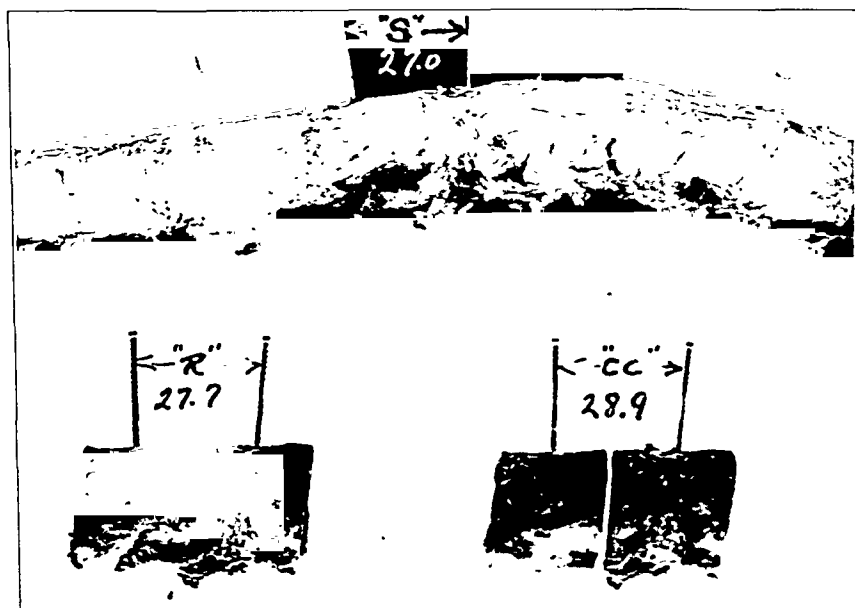


FIG. 1

Segment of spine showing values for S, R, and CC.

\*Read by invitation at the Annual Meeting of the American Orthopaedic Association, Toronto, Canada, June 18, 1932.

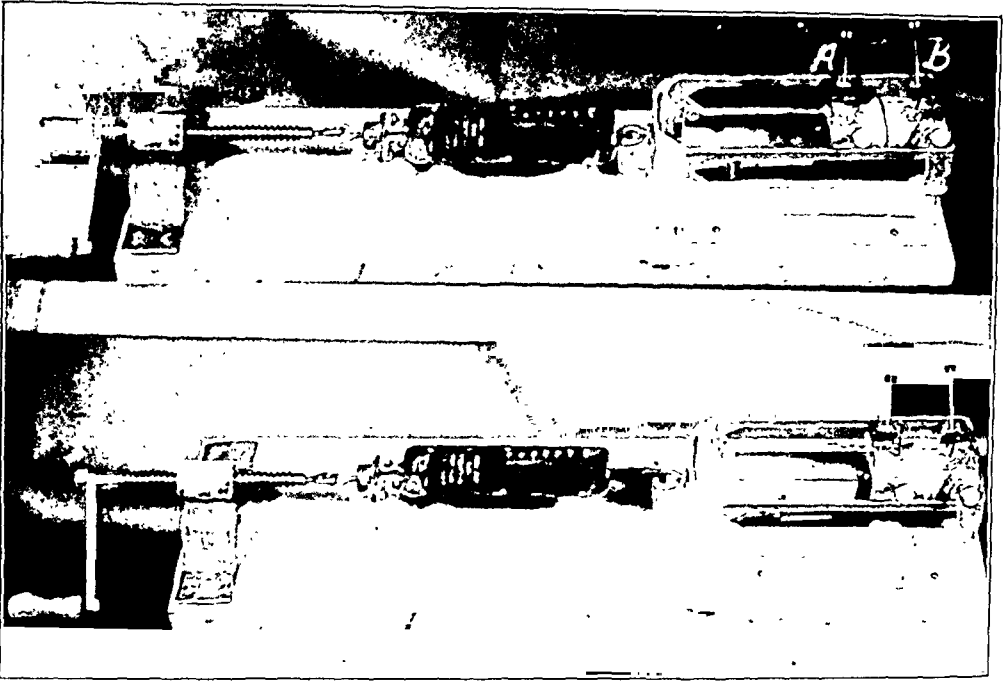


FIG. 2

"Compressor" with block in position, scale at zero, showing space between bodies which is overcome, in lower picture, by applying pressure of twenty-five pounds.

markers to each body and recording the distance  $S$  between them while *in situ*, and the distance  $R$  when removed. Further release of the restraining forces was accomplished by sectioning the annulus fibrosis of each disc throughout its circumference, and it was then found that the distance between markers  $CC$  had further increased *in most cases*.

Our first group of cases showed an average increase of seven-tenths of one millimeter in distance between markers upon removal of the block, and a further increase of one and two-tenths millimeters when the annulus fibrosis was cut.

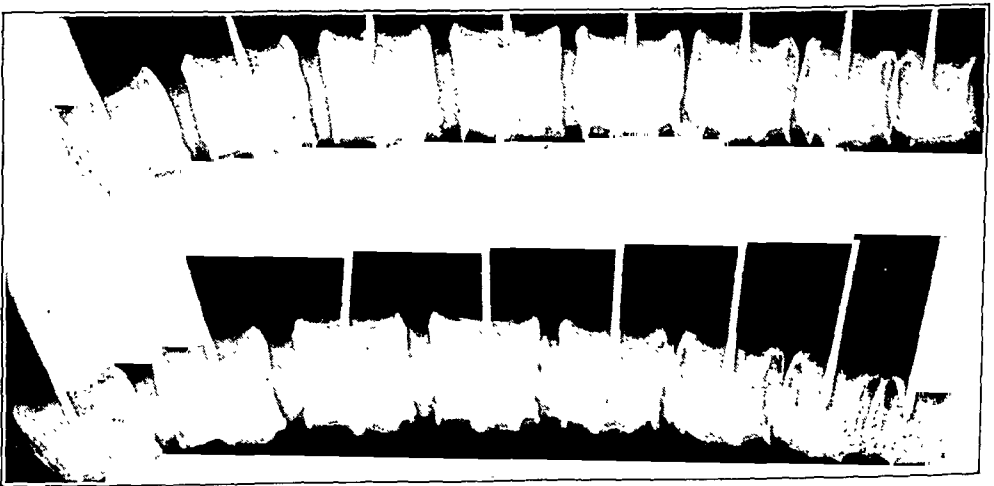


FIG. 3

Roentgenogram of spine segment before and after injection of each disc, showing increased curve produced by injection.

TABLE I

## EXPANSION AND COMPRESSION DATA ON SERIES OF DISCS STUDIED

Disc	Case	Sex	Age	B.L.	HR.	PM.	S	R	CC	Pressure
4 L	3715	F	21	163	8		32.0 mm.	32.75 mm.	33.75 mm.	32 pounds
	3337	M	46	166	8		39.5 mm.	40.0 mm.	41.0 mm.	32 pounds
	1630	M	51	181	12		36.0 mm.	36.0 mm.	36.5 mm.	32 pounds
	3605	F	44	161	2		33.0 mm.	34.0 mm.	35.0 mm.	32 pounds
2 L	3715						30.0 mm.	31.0 mm.	32.0 mm.	32 pounds
	3337						34.0 mm.	35.0 mm.	36.0 mm.	28 pounds
	1630						30.0 mm.	30.0 mm.	30.75 mm.	30 pounds
	3605						30.5 mm.	31.5 mm.	32.5 mm.	30 pounds
	2854	F	23	161	15		28.5 mm.	29.0 mm.	29.5 mm.	30 pounds
	4596	F	24	162	1.5		37.5 mm.	38.0 mm.	38.5 mm.	35 pounds
	4709	F	50	156	4		38.0 mm.	39.0 mm.	40.0 mm.	30 pounds
	4717	F	31	164	9.5		40.0 mm.	40.5 mm.	42.0 mm.	30 pounds
1 L	4712	M	22	173	5		40.0 mm.	40.5 mm.	42.0 mm.	32 pounds
	2905	F	29	163	9		35.5 mm.	35.5 mm.	37.0 mm.	24 pounds
	4257	M	43	174	8		37.0 mm.	37.0 mm.	38.5 mm.	32 pounds
	4785	F	21	162	5		35.5 mm.	35.5 mm.	37.5 mm.	32 pounds
12 D	3732	M	27	179	8		37.5 mm.	38.0 mm.	38.6 mm.	25 pounds
	3715						25.0 mm.	26.0 mm.	26.75 mm.	30 pounds
11 D	4357	F	21	133	1.5			26.5 mm.	28.0 mm.	30 pounds
	2905						26.0 mm.	26.0 mm.	28.0 mm.	30 pounds
10 D	4257						29.5 mm.	29.5 mm.	30.5 mm.	28 pounds
	4785						30.5 mm.	31.0 mm.	32.5 mm.	32 pounds
	3715						23.0 mm.	23.5 mm.	24.0 mm.	30 pounds
	3605						22.5 mm.	23.5 mm.	24.0 mm.	30 pounds
	2854						25.0 mm.	25.0 mm.	26.0 mm.	30 pounds

The question then arose as to how this expansile force could be measured. Therefore, a device was constructed by which a known force could be applied to the sectioned disc in an attempt to reduce the measurement *CC* to *R*. This "compressor" consists of a fixed cup, *A*, into which one vertebral body is fastened, and a second cup, *B*, to receive the other body. This second cup is pulled against the first by a screw which has a spring scale attached.

Markers are driven into the vertebrae adjacent to the disc to be studied and *S* recorded. The "block" is removed from the body by sectioning the discs above and below the one in question and by cutting the pedicles of the adjacent vertebrae. *R* is then recorded. After the an-

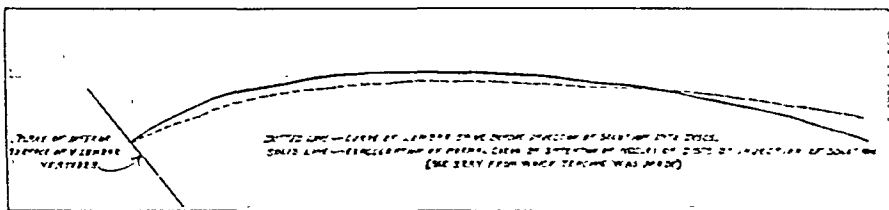


FIG. 4

Graphic representation of curves shown in Fig. 3.

TABLE II

## AVERAGE EXPANSION AND AVERAGE PRESSURE REQUIRED FOR REDUCTION

4th Lumbar	0.9 mm. expansion	Reduced by 32 pounds' pressure
2nd Lumbar	0.97 mm. expansion	Reduced by 30.6 pounds' pressure
1st Lumbar	1.4 mm. expansion	Reduced by 28.2 pounds' pressure
12th Dorsal	1.1 mm. expansion	Reduced by 30.0 pounds' pressure
11th Dorsal	1.5 mm. expansion	Reduced by 30.6 pounds' pressure
10th Dorsal	0.66 mm. expansion	Reduced by 30.0 pounds' pressure
Average	1.08 mm. expansion	Reduced by 30.2 pounds' pressure

nulus fibrosis is sectioned and *CC* observed, the "block" is fastened into the compressor and pressure applied to reduce *CC* to *R* (Fig. 2).

As a definite example of what actually takes place, we see from Table I that in Case 3715, observing the fourth lumbar disc:

*S* was found to be 32 millimeters; *R*, 32.75 millimeters; and *CC*, 33.75 millimeters.

A force of thirty-two pounds was required to reduce *CC* to *R*.

It is to be noted that the figures for expansion and compression show a variation, but the average for the group is found to be:

An expansion of 1.08 millimeters is reduced to normal by a pressure of thirty and two-tenths pounds.

The x-ray shadow of an opaque solution (sodium iodid, ten per cent.), injected into the center of the disc, shows that it is definitely limited, apparently by the annulus fibrosis. It was found that from eight-tenths to one and five-tenths cubic centimeters of solution was all that could be forced into these discs and, when this point was reached, the disc was slightly bulging.

In a large block, as the one shown, the injections produced an exaggeration of the normal curves of the segment of spine studied (Figs. 3 and 4).

## CONCLUSION

1. A very definite expansion of the intervertebral disc occurs upon its removal from the body, with further expansion when the annulus fibrosis is sectioned, the average being one and eight-hundredths millimeters.

2. An appreciable amount of pressure is required to reduce this expansion, the average being thirty and two-tenths pounds.

# EROSIONS OF THE ARTICULAR SURFACES OF THE KNEE JOINT

BY E. LAWRENCE KEYES, M.D., ST. LOUIS, MISSOURI

*From the Department of Anatomy, Washington University, School of Medicine \**

Certain lesions of articular surfaces were recently observed in many knee joints of a series of human cadavera. Some of these lesions do not appear to have been described previously, and others only briefly. Their causes and consequences are equally obscure. This paper aims simply to point out the gross features of the lesions, together with their frequency of occurrence and situation, based on a study of seventy-four successive unselected dissecting-room cadavera.†

*Definition.* The lesions under consideration have been termed "erosions", a name suggested by their appearance and location, and convenient for the description that follows.

*Description of the Erosions.* All erosions were found to be confined to the articular surfaces of the bones of the knee joint. The form varied; some were nearly circular in outline, others oval, and others of irregular form. The oval form was most common. In sizes they varied from two millimeters to four centimeters in diameter. Some appeared as a mere local roughening of the superficial layers of cartilage; others were punched-out lesions partly perforating the articular cartilage, and a few completely perforated the cartilage and exposed underlying bone. Synovial surfaces were ordinarily smooth and glistening. Multiple lesions within a single knee joint were the rule. Opposing bony surfaces were usually involved. Thus, it was rare to find an erosion of the patella without a corresponding erosion of the patellar surface of the femur.

*Incidence.* Erosions were found in the knee joints of forty-seven of the seventy-four cadavera examined, an incidence of sixty-three and five-tenths per cent. Among fifty-seven male cadavera, the incidence was sixty-four and nine-tenths per cent.; among seventeen female cadavera, it was sixty per cent. The incidence among thirty-two white cadavera was sixty-eight and seven-tenths per cent., compared to an incidence of sixty per cent. among forty-two negro cadavera.

*Side Involved.* Both knee joints of forty cadavera presented erosions; one knee joint only in seven cadavera. Of the seven latter, five were right knees and two were left.

*Location of the Erosions.* The knee bones of the forty-seven affected cadavera were involved in the following order of frequency: patellae, forty-two right and thirty-eight left; femora, thirty-five right and thirty-five left; and tibiae, fifteen right and ten left.

\* This investigation was aided by a grant from the Science Research Fund of the Rockefeller Foundation.

† The author wishes to express to Mr. Richard A. Sutter and to Mr. William S. Wallace his appreciation of their assistance in the collection of the material for the present study.

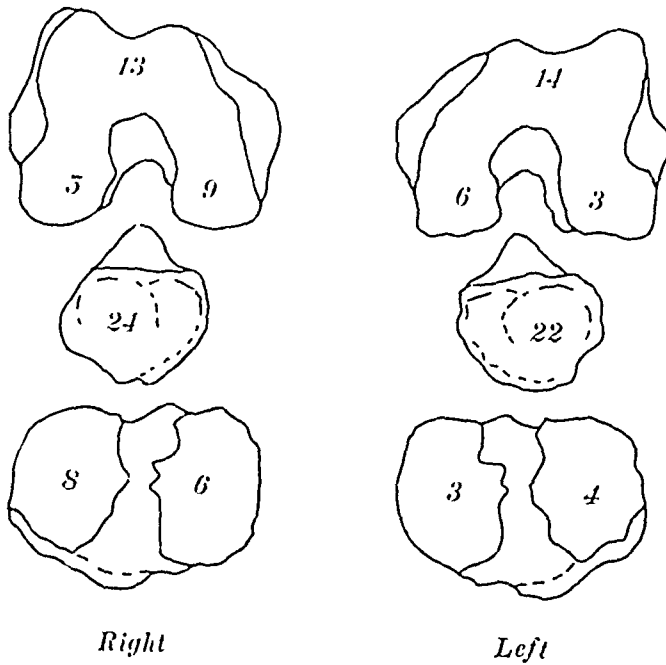


FIG. 1

Location and frequency of the erosions in the twenty-five abnormal cadavera.

The patellar erosions were all single, the erosions elsewhere were often multiple. There was usually one erosion to each articular subdivision. Of the twenty-five cadavera with erosions, forty-six patellae, representing twenty-four right knees and twenty-two left, were eroded; as were twenty-seven patellar surfaces of femora, eight lateral condyles of femora, fifteen medial condyles of femora, twelve lateral condyles of tibiae and eight medial condyles of tibiae (Fig. 1).

The average number of

erosions per affected cadaver was five; the average number per eroded knee joint was two and a half.

*Relation to Age.* The average age of all cadavera of the series was fifty-four and four-tenths years. The average age of cadavera with eroded knee joints was fifty-nine and nine-tenths years. Only twelve cadavera out of the thirty-two below the age of fifty had erosions, compared to thirty-five out of the forty-two over the age of fifty. The youngest abnormal cadaver was twenty-six; the youngest normal cadaver was sixteen. Past the sixtieth year there were thirty-one cadavera of which only four were free from knee-joint erosions.

There were also more erosions per knee joint among older cadavera. Six cadavera, averaging seventy-one and eight-tenths years, exhibited erosions on all six bones of the two knee joints; nine cadavera, averaging sixty-three and three-tenths years, had erosions on five of the bones; thirteen cadavera, averaging sixty-four and six-tenths years, presented four of the bones eroded; five cadavera, averaging fifty-one years, showed three of the bones involved; ten cadavera, averaging fifty-six and one-tenth years, revealed but two affected bones; and three cadavera, averaging forty-six and seven-tenths years, suffered a single eroded bone.

In addition to being more numerous in the knee joints of older cadavera, the erosions were generally more extensive. Thus the three cadavera, possessing erosions extensively exposing bone, averaged seventy-three and seven-tenths years of age, well above the average of affected cadavera,—namely fifty-nine and nine-tenths years.

*Relation to Disease and Trauma.* The cause of death in all the cadavera of this series was known. Examination of the case histories afforded

no aid in associating the lesions with symptoms or with trauma.

*Erosions Elsewhere.*

Erosions, similar to those described in the knee, were observed in the shoulder and radiocarpal joints of some cadavera. No attempt was made to include these lesions in the study, however.

COMMENT

Erosions of the articular surfaces of the knee, shoulder, radiocarpal, and temporomandibular joints have been described by Meyer.<sup>1</sup> His descriptions of the knee-

joint lesions are confined to those occurring on the patella. The erosions of the condyles of the femur and of the tibia noted in this study do not appear to have been recorded previously, although they are included in a study at present in progress<sup>2</sup>. Lesions similar to those here described have been observed in the carpometacarpal joints of apparently normal slaughter-house animals by Bennett and Bauer<sup>3</sup>.

That the lesions in man have their origin during life is conclusively proved by their demonstration at necropsy. Myers<sup>2</sup> very kindly showed the author some knee joints opened at necropsy in which the erosions were readily seen.

The cause of the lesions is obscure. This study throws some light on certain etiological factors. The erosions occur in the majority of cadavera over fifty, and are more numerous and more extensive in older cadavera. They affect males more often than females. They are usually bilateral. The pattern of the erosions is likely to be similar in the two knees. Opposing joint surfaces are apt to be involved, particularly the patella and the patellar surface of the femur. Only the articular cartilage of the joint structures appears to be affected. The lesions sometimes lead to exposure of large bony surfaces within the joint. These observations point to age and trauma as important causative factors. The lesions would seem to be degenerative changes.

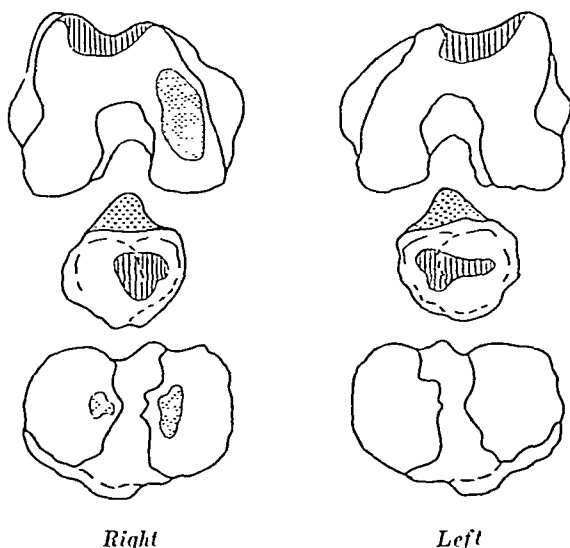


FIG. 2

Erosions in the knee joints of a negro male cadaver, aged sixty-five years. The striated areas represent striated bone exposed. The stippled areas represent simple erosions.

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## MARCH FOOT

BY J. S. SPEED, M.D., AND T. H. BLAKE, M.D., MEMPHIS, TENNESSEE

Due to lack of understanding of the etiology of the condition, march foot is the name given to a definite clinical entity, consisting of a painful swelling of the forefoot often associated with an insidious spontaneous fracture of one of the metatarsal bones. The condition has been well recognized for many years, especially by the German and French Military Surgeons who frequently encountered it among their troops after strenuous duties or long marches,—hence the name of “march foot”.

The first description found in the literature was by Breithaupt<sup>4</sup> in 1855, who clearly distinguished it from the usual anterior metatarsal strains or from Morton's toe, a malady from which he himself suffered.

Very little has been added to his original clinical description, although he did not observe or recognize the associated spontaneous fractures of the metatarsal bones which we now know are present in the majority of the well developed cases. Since that time numerous articles have appeared in the German and French literature under the titles of “Foot Tumor”, “Foot Oedema”, “Syndesmitis Metatarsae” and “Pied Forcé”.

The usual history and clinical appearance is typical. A soldier after a long march, or a civilian who has been subjected to excessive foot strain, begins to complain of an indefinite pain in the forefoot, and some tenderness over the anterior portion of the second or third metatarsal. This is not sufficient to disable the patient and he continues with his duties only to have the disability increase, and after a few days a definite swelling is noticed involving the dorsal surface of the forefoot. The condition improves with rest, but resumption of use of the foot aggravates the condition and it is usually only after several such attacks that the patient first consults a physician.

Very few patients give a history of any direct trauma, either severe or trivial, that could account for the symptoms.

Examination reveals an oedematous forefoot, most marked over the metatarsal region. The skin appears shiny and tense, there is some localized heat and redness. The swelling is usually limited entirely to the dorsum of the foot, most marked in the region of the second and third metatarsals, the plantar surface of the foot only being involved in the more extreme cases. The swelling pits on pressure with the sensation that most of the oedema and tenderness lies deep beneath the fascia.

In the later stages, after two or three weeks, the swelling has become more localized over the shaft of one of the metatarsals and a firm tumor-like mass can be definitely distinguished, attached to the bone. Bony crepitus has never been felt, although manipulation of the affected metatarsal produces localized pain at the point of fracture or beginning fracture. Motion in the ankle joint and uninvolved parts of the foot is free and painless.

There is usually a definite limp, and, if a fracture is present, the patient cannot stand with the weight on the ball of the affected foot.

Clinically the cases may be divided into two groups. The first group has the usual onset and progresses to the stage of swelling over the dorsum of the foot, and localized tenderness over the affected metatarsal. With rest and treatment, and frequently without treatment, the process apparently becomes arrested and after a week or ten days the swelling and pain subside and the foot returns to normal, without formation of a localized tumor or the occurrence of a spontaneous fracture. Roentgenograms taken during the course of the active symptoms or at intervals afterwards fail to show any bony changes.

The second group, in which the onset is identical with the first, progresses through the stages of periosteal proliferation, spontaneous fracture, and excessive callus formation. The duration of symptoms in this group is naturally much more prolonged, the average being two to three months. At the end of this time the fracture is united, the callus gradually condenses and eventually disappears, leaving a bone which is perfectly normal clinically and in which the x-ray shows no residual changes or at most only a slight thickening of the cortex at the site of the fracture.

There is considerable disagreement regarding the percentage of cases in which spontaneous fractures occur. This is probably due to the personal equation in selecting the early cases, to the conditions under which they were observed, and to the improvement in x-ray technique which has enabled us to detect the fine fracture lines which would not be visible in a poor roentgenogram. Most of the larger series were reported from the German Army many years ago. These cases were under careful medical supervision, were recognized early, and the patients were kept off their feet until the symptoms disappeared. X-ray studies were not routine and it is probable that many fractures were not detected. Even with the best roentgenograms today, the fracture line is often difficult to make out, due to the fact that there is no displacement of the fragments and the fracture site is obscured by an abundant callus.

Bähr<sup>1</sup>, states that in 2146 foot tumors there were fractures in 877 or forty-one per cent. The percentages given by other authors vary from twenty to ninety. It is probable that in civilian life only the more severe cases seek medical attention or are recognized as march feet, consequently the percentage is much higher.

Although many theories have been advanced regarding the etiology of the condition, as yet no explanation has been offered which is entirely satisfactory. The reader is referred to the rather voluminous literature for the details of these theories or to a recent article by Straus<sup>12</sup> in which a summary of the various articles is given.

Unquestionably the incipency of the disease is associated with an excessive or prolonged foot strain. It is possible that this results in a fatigue of the muscles and stretching of the ligaments supporting the concavity of the metatarsal bones and the anterior metatarsal arch. This

allows the weight to fall heavily on the unsupported heads of the second and third metatarsals and eventually produces a fracture by repeated tension and trauma. This is shown in the present series, by the fact that five of the cases reported were of nurses who were on their feet an unusual amount, walking on tile floors. Two of the other cases were patients who had recently engaged in occupations requiring much walking on the streets. There was one who had recently gained much weight and walked in spike-heeled shoes. Again, all the original cases reported were in soldiers who participated in long or protracted marches. All of the authors' patients gave a history of previous foot ailments, the usual being bunions, calluses under metatarsal heads, and rigidity of the tarsal and tarso-metatarsal joints. This shows that some type of chronic foot strain has been in progress over a more or less long period of time.

Disturbance in function of the anterior metatarsal arch as an etiological agent is strongly supported by a study of the mechanics of weight-bearing in the anterior metatarsal arch. With the foot at rest or with the heel flat on the floor, the majority of the weight falls on the heads of the first and fifth metatarsals, but when the heel is raised in the act of walking the anterior arch flattens and the weight is shifted to the heads of the second, third, and fourth metatarsals. This is evidenced, not only by observation of the normal foot, but by the fact that in conditions where the normal flexibility of the anterior arch is lost, callus formation on the ball of the foot is most frequently found under the heads of these three bones, showing that pressure is greatest at these points.

It is impossible to say whether the spontaneous fracture is directly the result of mechanical stress on the bone or whether it is indirectly caused by a disturbance in the nutrition of the metatarsal from a myositis and fibrosis of the intrinsic muscles attached to these bones, interfering with their blood supply.

Study of the roentgenograms in the authors' group of cases has been most interesting and instructive. They have helped greatly to explain the clinical course of this affection and to explain the pathological changes noted in the bone after the "foot tumor" has become fully developed.

The roentgenograms of a march foot are at times difficult of interpretation if only one set of pictures are made, but if a series of roentgenograms are made, beginning early after the onset of symptoms and repeated every two weeks, it will be seen that the bone changes follow an orderly course, differing very little from the healing of an ordinary fracture. Good roentgenograms with clear detail are essential to bring out the fine fracture line which at first is very difficult to see and later may be obscured by excessive callus formation surrounding it. A magnifying glass will assist in identifying the fracture line.

We have been fortunate in securing a complete series of roentgenograms in several cases, starting before there was any evidence of bone changes and following them through the various stages of early periosteal proliferation, the appearance of the fracture line, the formation of ex-

cessive callus, the healing of the fracture with contraction of the callus, and eventual restoration of the apparently normal bone. The normal sequence of changes shown by the roentgenograms are as follows:

1. If taken very soon after onset of symptoms the bones will be found to be entirely negative and only swelling of soft tissues will be noted.

2. After one to three weeks there will be a little periosteal fuzziness at the site of the beginning fracture; very close observation may show a minute line of fracture. Occasionally the fracture appears before the periosteal reaction is seen.

3. A little later the periosteal shadow will become more distinct and circumscribed and it will be noted that this callus is overabundant for the size of the bone involved and the size of the fracture. At this time the fracture usually can be seen distinctly and will be found to have an irregular outline.

4. The fracture is next showing signs of union and the callus is more dense and well circumscribed into a spindle shape. At this stage and in the preceding one, this condition has been mistaken for sarcoma which it simulates to some extent.

5. Pictures taken six months later will show solid union with absorption of the excess callus. The shaft will appear normal except for a small amount of residual cortical thickening.

Displacement of the fragments in these fractures is very infrequent. This is probably explained by the fact that the fracture is produced gradually, without violence to separate the ends, and that the periosteal thickening and early callus formation are present simultaneously or preceding the actual dissolution of the bone. The protective splinting afforded by the other metatarsals is probably also a factor. Case 2 (Fig. 3) is the only patient in this series which showed an appreciable displacement. There was no history of trauma in this case.

Rarely the fracture line appears before there is any sign of periosteal proliferation. Such a case is illustrated in Case 6 (Fig. 2). Later callus appeared, just as in an ordinary fracture, and healing progressed in the usual manner.

A more frequent finding is for the x-ray to show an actively proliferating mass of callus about the shaft of the metatarsal without a definite fracture line being discernible. The bone usually shows some rarefaction and resorptive changes, and it is thought that in all of these cases there is a dissolution in the continuity of the shaft even though no fracture line can be seen. This does not seem unreasonable when we realize that some of the very definite fractures are only revealed as such by the aid of a magnifying glass.

Fracture of more than one metatarsal is extremely rare. Figure 4-C illustrates the only case in our series showing a double fracture. Except for the excessive callus formation, which may easily be the result of lack of immobilization, the healing of these spontaneous fractures and the eventual restoration of the bone to its approximately normal

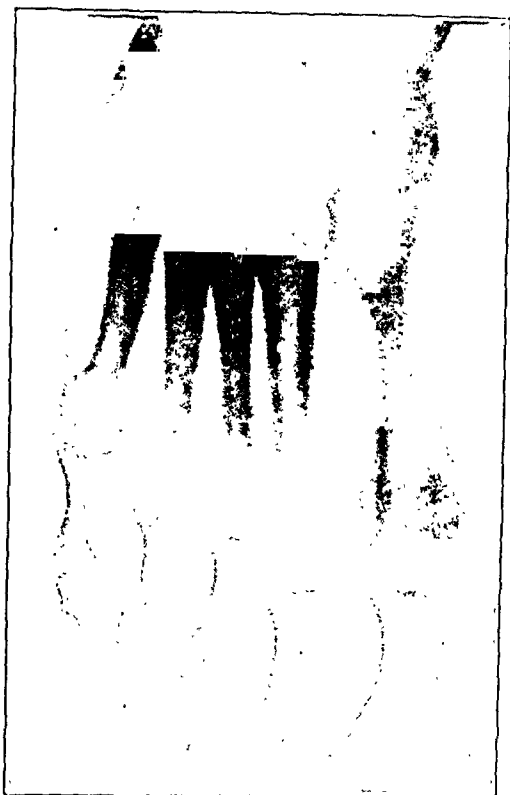


FIG. 1-A

Case 1. Typical tumor-like mass of periosteal proliferation characteristic of march fracture.



FIG. 1-B

Case 1. Roentgenogram of same foot eleven years after Fig. 1-A, showing restoration of normal bone, except for slight cortical thickening.

condition does not differ from the repair of an ordinary fracture.

The treatment of march foot depends upon the period in the disease at which the diagnosis is made.

Recognition of the prodromal symptoms, before fracture has occurred, is important, because at this time the production of the fracture may be prevented by proper prophylactic measures. With rest, hot applications, and relief from weight-bearing, the condition may be arrested during the stage of preliminary swelling, and the foot return to normal after a week or ten days. Toe exercises to restore the flexibility of the anterior metatarsal arch and a proper arch support or strapping of the forefoot should be employed when walking is resumed. Because of economic reasons many patients are unwilling to accept the period of complete rest and in these cases strapping of the forefoot gives the most relief.

After the fracture and callus production have occurred, the treatment will vary according to the severity of the symptoms. Some patients have remarkably little pain and eventually make a complete recovery regardless of what is done for them. Strapping, arch supports, and physiotherapy lessen the pain and shorten the period of disability. Other foot abnormalities which may be present should receive the proper attention.



FIG. 2

Case 6. March fracture, the third metatarsal showing appearance of definite fracture line previous to callus formation.

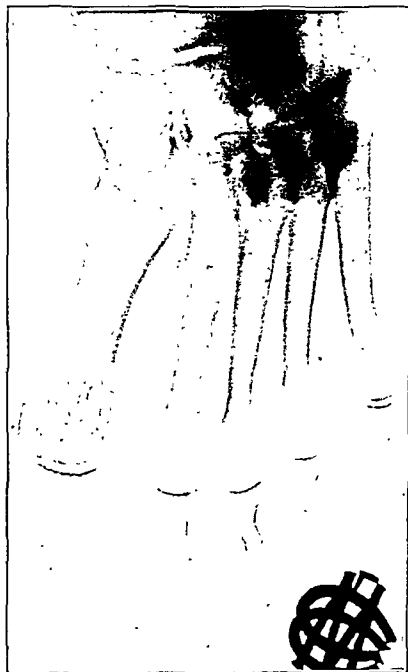


FIG. 3

Case 2. Unusual type of March fracture showing slight displacement of fragments.

The average disability, where fracture has occurred, is from four to eight weeks. Although suffering varying degrees of pain, very few patients will give up their work, but will continue to limp about, satisfied with the partial relief given by the strapping and arch supports.

The following is a brief report of ten fractures in nine patients:

#### CASE REPORTS

CASE 1. Miss M. S. I., female, trained nurse, aged thirty-five years, gave a history of pain in both feet extending back for a period of several years. The pain was relieved by flat-foot strapping. Two months before examination patient began having pain in the right foot and the right leg, the pain was worse in the arch of the foot and in the calf of the leg; two weeks prior to examination she began having a dull aching pain in the ball of the foot in the region of the third and fourth metatarsals.

Examination on October 19, 1921, showed longitudinal arches normal, some rigidity of the anterior metatarsal arch, and limitation in flexion of the toes of the right foot, acute pain over dorsum of the third and fourth metatarsals. Head of the third metatarsal was depressed and there was some swelling over the dorsum of the foot.

On October 25, 1921, the patient returned, complaining of increased pain in the foot. Examination showed a firm nodular thickening in the center of the shaft of the third metatarsal. There was a visible and palpable tumor-like nodule in the center of the third metatarsal, no local redness nor heat.

X-ray examination showed a rounded mass of periosteal thickening about the center of the third metatarsal. No definite fracture line could be determined. Subsequent

roentgenograms on November 28, 1921, and on January 4, 1922, showed a gradual condensation of the tumor mass.

The patient's symptoms gradually disappeared and she has had no trouble in the foot since. The last roentgenograms, taken July 9, 1932, showed restoration of practically normal appearance of the bone except for a slight amount of cortical thickening at the site of the previous periosteal proliferation.

**CASE 2.** Mrs. G. W. A., housewife, aged fifty-six years. In June, 1927, this patient began complaining of pain on dorsum of the left foot just back of the heads of the metatarsal bones. The pain became worse after walking and it improved with rest. There was no history of trauma. The foot swelled after use.

Examination on July 15, 1927, showed an old infectious arthritis of the feet with moderate claw-toe deformity. The longitudinal arches were normal; there were calluses under the heads of the second, third, and fourth metatarsal bones. There was swelling over the dorsum of the foot more marked over the second metatarsal bone with pitting oedema.

Roentgenogram showed a fracture near the proximal end of the second metatarsal with excess callus formation.

The patient was treated by means of strapping and arch supports. The symptoms gradually disappeared, and in November, 1927, she was free of symptoms from the fracture.

**CASE 3.** J. W. McP., male, physician, aged thirty-five years. Patient stated that he had always had flat feet but that they had never given him any trouble until about six weeks prior to his examination on September 1, 1928, when he bruised the sole of his



FIG. 4-A

Case 4. Preliminary roentgenogram soon after onset of symptoms. No fracture nor periosteal thickening seen.



FIG. 4-B

Case 4. Five weeks later, showing a beginning periosteal thickening of second metatarsal. No definite fracture line seen.

left foot by stepping on a rock when wearing a thin-soled shoe. Since that time the foot had pained him severely when walking, and swelling developed over the dorsum and ball of the foot. There was a very tender spot to palpation over the base of the third metatarsal. He stated that pain in his foot was relieved by rest and that the pain increased when walking.

Examination showed a second degree planus; moderate swelling over the dorsum of the left foot and along the extensor tendons, most marked over the second metatarsal; no tendon nor bone crepitation. Tenderness was quite marked over the base of the second metatarsal, where a firm thickening over the bone could be felt. No other abnormality could be made out in the foot.

X-ray examination showed a fine periosteal proliferation in the upper half of the second metatarsal bone, producing a rounded tumor-like nodule. There was an indefinite fracture line through the shaft of the metatarsal at this point.

The patient was treated with strapping of the forefoot and arch supports, and he remained active in his practice. The symptoms gradually subsided and he has had no pain since.

CASE 4. J. F. O., a male, aged sixty, in the insurance business. The patient stated that he had suffered pain in the forefoot for two or three years; the onset occurred rather suddenly without history of injury. About two months prior to his examination on December 11, 1930, he developed pain in the right foot, localized chiefly in the metatarso-



FIG. 4-C

Case 4. Six weeks later, showing condensation of callus and healing of fracture in second metatarsal, also a second spontaneous fracture at distal end of third metatarsal with beginning union.

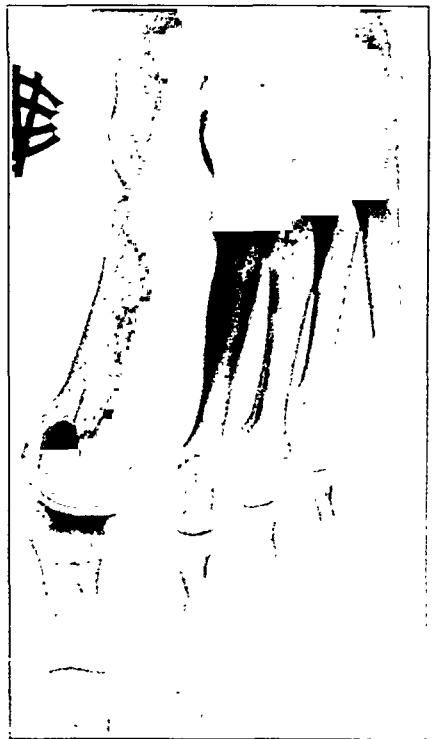


FIG. 4-D

Case 4. Ten months later, showing healing of both fractures and restoration of practically normal appearance of bone.



phalangeal region. The pain was worse on walking and it improved with rest. The symptoms gradually increased until at the time of his examination he walked with a limp.

Examination of the foot showed considerable swelling and oedema over the dorsum of the forefoot; the skin was slightly reddened, and there was pitting on pressure; there was tenderness over the second metatarsal just proximal to the metatarsophalangeal joint; there was no bone nor tendon crepitation.

Roentgenograms on December 11, 1930, showed the bones of both forefeet negative, no evidence of fracture or periosteal proliferation. It was thought that the patient probably had infectious arthritis, and treatment was instituted for same without improvement.

On January 10, 1931, the swelling over the metatarsal bones had practically disappeared. The patient complained of pain in the anterior metatarsal arch and there was limitation of motion in the toes. Anterior metatarsal strapping was applied.

On January 17, 1931, examination showed recurrence of swelling over the forefoot. There was a localized area of tenderness over the second metatarsal, pain and disability in the foot continuing.

Roentgenograms made on January 17, 1931, showed a beginning periosteal thickening near the center of the second metatarsal; no definite fracture line could be made out. The patient was fitted with arch supports. He returned on February 27, 1931. The swelling and pain in the right foot had gradually decreased, but there was still a painful area in the mid-portion of the second metatarsal and over the distal end of the third metatarsal. The patient had been walking all day with the aid of arch supports and suffered a moderate amount of pain.

Roentgenograms made on February 27, 1931, showed a condensation of callus on the second metatarsal bone and a fracture near the distal end of the third metatarsal with a fairly well condensed and healing callus.

Pain in the foot gradually decreased until in June, 1931, the patient was practically free from symptoms and he had been doing his ordinary work which required him to be on his feet all day. He continued to wear arch supports. This patient has had no symptoms in the opposite foot.

Roentgenograms taken October 26, 1931, showed a complete healing of both fractures with restoration of bone to practically normal appearance.

CASE 5. Miss E. E., aged thirty years, a student nurse. Patient stated that she had had no trouble with her feet until three days prior to her examination on December 20, 1930, when she developed pain in the left foot, most marked in the region of the fourth and fifth metatarsals. There was no history of injury. Condition improved with rest but recurred with resumption of duty. Examination of the left foot December 20, 1930, showed marked tenderness over the dorsum of the foot near the distal end of the third metatarsal. There was moderate hallux valgus present, first degree planus. The anterior metatarsal arch was flattened and there was limitation of motion in flexion and extension of the toes with callus formation under the heads of the second and third metatarsals.

The foot was strapped and the patient returned to duty. She was again seen on December 27, 1930, and stated that pain and swelling in the foot had persisted, that a very acute area of tenderness had developed over the shaft of the third metatarsal. Examination showed definite swelling over the metatarsal at this point. Roentgenograms made on December 27, 1930, showed a fracture line across the middle of the shaft of the third metatarsal without displacement of fragments and no callus formation.

Adhesive strapping was continued in this case, and on February 19, 1931, the pain, swelling, and disability in the foot had entirely disappeared. There was no local tenderness over the shaft of the third metatarsal.

Roentgenograms on February 19, 1931, showed that the fracture of the third metatarsal had united with good callus formation. This patient has been free from symptoms in the foot since.

CASE 6. Miss L. M., student nurse, aged twenty-three years. This patient complained of a painful left foot; she did not give a definite history of previous foot trouble, but stated that she had pain at the base of the fourth toe, and that three days prior to her examination on September 15, 1931, swelling developed over the dorsum of the foot. The foot had been strapped without relief. There was no history of trauma.

On examination, September 15, 1931, left foot showed definite swelling over the dorsum of the foot, more marked over the third metatarsal; there was slight increase in local temperature, no redness. The point of maximum tenderness was over the head of the third metatarsal bone, dorsal surface; the longitudinal arch of the foot was normal, and there was limitation of motion in all of the toes.

Roentgenograms on September 15, 1931, showed a fracture of the distal third, third metatarsal bone, no displacement of fragments, no definite formation of callus.

The patient was treated by strapping and arch supports with improvement in symptoms. She did not return for observation and no further follow-up in the case was obtainable.

CASE 7. Miss C. B., aged twenty-two, a student nurse. There was no definite history of previous foot trouble, the patient stated that she had been having pain and swelling over the dorsum of the left foot in the region of the second metatarsal bone for the two weeks previous to examination.

Examination on February 17, 1931, showed moderate swelling on the dorsum of the left foot in the region of the second metatarsal bone, tenderness on plantar surface of foot under the second metatarsal bone; there was a second degree planus of both feet with fixation of the anterior arch and limitation of motion in the toes.

X-ray examination on February 17, 1931, showed a very indistinct but definite fracture line through the second metatarsal just proximal to the head. The foot was strapped with adhesive tape and the patient remained on duty.

On March 20, 1931, the patient returned. The foot had been kept strapped; she had remained on duty since examination, and the pain and swelling had gradually disappeared.

On April 30, 1932, this patient stated that she had had no pain nor disability in the foot for the past year and she had continued on duty, training for a nurse. Examination on this date showed the foot to be normal in appearance and function.

X-ray examination on April 30, 1932, showed a thickening of the cortex of the second metatarsal bone at the site of the previous fracture. The fracture line had entirely disappeared.

CASE 8. Mrs. W. T. O., aged forty-five, housewife. Patient stated that three weeks prior to her examination, on January 11, 1932, she began having pain in the left foot over the metatarsal area; the foot gradually swelled during the day with increase in pain and disability after walking. There had been no redness nor sign of inflammation, the patient had continued to be on her feet although she suffered considerable disability.

Examination of the left foot showed slight swelling over the dorsal surface with tenderness over the upper portion of the shaft of the third metatarsal bone. The longitudinal arch was normal, there was slight hallux valgus present.

Roentgenograms on January 11, 1932, showed slight periosteal thickening at the proximal end of the second metatarsal bone. No definite fracture line was seen.

The foot was strapped and the symptoms gradually disappeared. No further roentgenograms were taken in this case, but at the end of two months she was entirely free from symptoms.

CASE 9. Miss A. M. S., aged twenty-one, a student nurse. Patient stated that she had had no previous history of foot trouble, that two weeks prior to her examination on April 4, 1932, she began having a mild aching pain in the metatarsal region of the right foot and a moderate swelling developed in this area. She remained on duty with only a moderate amount of discomfort.

Examination showed swelling over the dorsum of the right foot in the region of the third metatarsal; there was no redness nor increase in local heat; there was tenderness on pressure over the head of the third metatarsal and along the shaft of the third metatarsal. There was some limitation of motion in flexion and extension of the toes.

X-ray examination on April 30, 1932, showed an indefinite fracture line extending across the third metatarsal about one inch proximal to the head with beginning callus formation.

*Subsequent course:* The forefoot was strapped with adhesive tape; this was continued for from six to eight weeks when the patient was symptom free. She has had no trouble since.

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## THE EFFECT OF TREATMENT AND ERADICATION OF FOCI OF INFECTION IN CHRONIC ARTHRITIS (FOCAL INFECTION)\*

BY LEO J. MILTNER, M.D., PEIPING, CHINA, AND JACOB KULOWSKI, M.D., IOWA CITY, IOWA

This study is an attempt to evaluate the associated therapeutic significance of the treatment and, whenever possible, the eradication of foci of infection in chronic arthritis. It is based upon an analysis of 200 cases of chronic arthritis, which were submitted to an exhaustive search for, and the subsequent treatment of, all foci of infection. No cases have been included in which a complete diagnostic and therapeutic régime could not be carried out by the various medical and surgical departments of the hospital. All of these patients have been observed, at intervals of several months following their foci attention, from two to four years.

During the first period of hospitalization, the general condition of the patients demanded other treatment, especially physical rehabilitation and general hygienic measures, including diet and elimination. Consequently, fifty per cent. received some form of orthopaedic mechanical treatment. About twenty-five per cent. were also given dietary and physiotherapeutic care, which was continued at home following discharge from the clinic. Only five per cent. were given any form of medicinal therapy.

From this general preface, the difficulties encountered in attempting a selective clinical evaluation of this one therapeutic factor (foci of infection) are at once apparent. The writers are fully cognizant of this, but the results in this series do indicate the value of the continuance of the eradication of foci of infection, not only in chronic arthritis, but in all those conditions and diseases simulating the rheumatic syndrome. In this clinic this is routinely observed in all cases of chronic arthritis and associated conditions whenever feasible. Chronic arthritis is, therefore, considered to be a focal infection.

That focal infection has changed from a theory to a principle of infection has been due almost entirely to the mass of acquired practical evidence. Certainly, the laboratory background is confusing and less convincing than are the clinical observations. The hypothesis of "elective localization" has overemphasized the bacterial phases of the problem, and has naturally diverted attention from the underlying principles of infection. "When the apparent focus of infection has been removed, there may be an exacerbation of the secondary focus at the time of operation (tonsillectomy, extraction of teeth, *et al.*), or cure of the clinical condition may follow. *This is the criterion on which the principle of focal infection is mainly founded . . .*" (Holman). (The italics are ours.)

\* From the Department of Orthopaedic Surgery, State University of Iowa, Service of Dr. Arthur Steindler.

Practically all infections must have a portal of entry with a primary focus from which dissemination may occur. This principle is too broad, and focal infection has come to have a special significance, as distinct from focus of infection. A focus of infection is "a circumscribed area of tissue infected with pathogenic micro-organisms" (Billings). The term focal infection further implies that there has resulted secondary distant or contiguous systemic infection. The former occur by the lymphatics or the blood stream. The joint manifestations in chronic arthritis are then essentially metastatic secondary foci. The ideal eradication of all foci of infection is, therefore, practically impossible as long as there exists any degree of residual joint unsoundness.

"Systemic or general disease due to a local infection is a conception as old as medical knowledge." Mayo quotes Hippocrates as having recorded two cases in which the eradication of foci of infection of the mouth had relieved them of rheumatic troubles of the joints. Benjamin Rush, in 1801, stimulated interest in focal infection when he reported a cure of hip joint disease by the removal of the patient's tonsils. Billings, in 1890, began his classical investigations upon which the principles of focal infection firmly stand, and from which has sprung the key to the understanding of innumerable systemic diseases.

For purposes of convenience and clarity, this series of cases has been divided clinically into the two classic types—chronic atrophic arthritis and chronic hypertrophic arthritis—according to the classification adopted by the American Committee for the Control of Rheumatism.\*

The *hypertrophic form* (osteo-arthritis, degenerative arthritis) is characterized pathologically by lipping, fibrillation, and splitting of the cartilage, and erosion by attrition, sclerosis, eburnation, and grooving of the underlying bone. There is no general proliferation of the synovial membrane nor marked evidences of inflammatory infiltration. Clinically, it is characterized by its occurrence usually in older, well nourished, stocky individuals of good general health. There is some degree of pain and stiffness of the joints, grating and crepitation, and deformity due to bony outgrowths. Limitation of motion is due to mechanical bony blocks.

The *atrophic form* (rheumatoid arthritis, infectious arthritis, proliferative arthritis, etc.) is characterized pathologically by inflammatory proliferation and infiltration of the synovial membrane, atrophic bony changes, erosion of the articular cartilage independent of attritional influences (at periphery), and fibrous adhesions or ankylosis. The clinical features include its occurrence in younger asthenic individuals whose general condition is not robust, the evidence of a more or less subacute inflammation, pain and limitation of motion of the joints and a tendency to contracture formation, periarticular tissue involvement with fusiform swelling, and a marked tendency to fibrous or bony ankylosis.

\* There may be no sharp dividing line between the two groups, but pathologically and clinically there are usually present certain salient features by which they are differentiated.

## CLINICAL ANALYSIS OF END RESULTS

I. *Chronic Atrophic Arthritis* (100 cases)

The favorable reactions to foci attention were so striking in the younger patients that a division into two main age groups seemed advisable (See Tables I and II). The first group represents all cases ranging from infancy to sixteen years of age inclusive.

## A. Children and adolescents, thirty-seven cases.

The arthritides are so commonly observed in the young that particular emphasis is warranted. The disease was polyarticular as a rule and usually involved one or more of the larger joints. There were five patients with advanced Still's disease, who exhibited enlargement of the liver, spleen, and lymphatic nodes, and were markedly emaciated. In these the effects of foci eradication were in no way comparable to the results obtained in earlier cases which did not have such systemic complications. Otherwise, the symptoms and findings resembled the usual adult types of the disease.

The foci of infection situations were almost exclusively found in the upper respiratory tract (Table I). Seventy-three per cent. (27 cases) of this entire group (Tables I and II) were apparently cured following the eradication of foci of infection; sixteen per cent. (6 cases) were markedly improved, and eleven per cent. (4 cases) showed no improvement, the latter all being cases of Still's disease. The associated pediatric and orthopaedic care consisted largely of dietary management, along with rest and immobilization of the affected joints. The search for foci was sometimes difficult and tedious and required a number of examinations as well as repeated attentions by those who had had special training in otolaryngology of children, as the following case report demonstrates.

The patient was a female child two years of age, and seen August 1925. The disability resulted from painful polyarthritis of one year's duration. The joint involvement followed a severe diarrhoea, and was accompanied by fever. Since the onset there

TABLE I  
SITUATIONS OF FOCI OF INFECTION IN 100 CASES OF CHRONIC ATROPHIC ARTHRITIS

37 patients up to 16 years of age inclusive	Situation	63 patients over 16 years of age (adults)
No foci	Dental.....	22 foci
24	Tonsillar.....	16
9	Paranasal sinuses.....	14
No foci	Gastro-intestinal.....	13
No foci	Genito-urinary.....	12
6	Ear and mastoid.....	1

Of the entire group only fifteen cases had more than one focus per case present; the remaining eighty-five cases had only one demonstrable focus of infection per case that required treatment. Such findings do much to simplify the problem of foci attention. The rule should be to treat every definite focus of infection found in a case of chronic atrophic arthritis, whenever possible. It will be noted that the foci are more wide-spread in the adult group.

had been several exacerbations of acute joint pain and swelling, the last attack being associated with an acute upper respiratory infection. On admission to the hospital, the child was markedly emaciated and had multiple joint enlargements and mild deformities. Special examination revealed chronic disease of the tonsils and adenoids. Significant laboratory findings were the 30,400 white blood count, and the pus cells, and one plus albumin in the urine. The tonsils and adenoids were removed, following which the temperature returned to normal, and much of the pain and swelling in the joints disappeared. The tendency to loose stools disappeared and the pyelitis cleared up. The weight gradually increased during the next two weeks. The patient was discharged from the hospital, but returned four months later. At that time, examination showed that the patient had improved considerably, but the joints soon became subacutely involved and remained thus for two months. The nasal sinuses were thought to be the seat of chronic infection, which examination under anaesthesia showed to be the ethmoids. The ethmoidal labyrinths were curetted out from each side. The operator reported marked disease of the ethmoidal labyrinths with thickened membranes and hypertrophic softened bone. Because of insufficient improvement, following this radical procedure, the patient was operated upon again and, at this time, macroscopic pus was also found in both maxillary sinuses. The predominating organisms in the pus obtained from the sinuses were long chain streptococci. Because of the age of the patient, it was necessary to use ethylen anaesthesia in order to perform the repeated irrigations of the sinuses. Three weeks following the irrigation treatment, definite improvement in the joints was noted. The patient looked greatly improved and had gained considerable weight. The patient had several mild exacerbations of fever with mild reinfection of the ethmoidal sinuses, and, with each flare-up of infection, the joint symptoms became more noticeable. The close relation between infection of the sinuses and the presence of joint symptoms, pyelitis, and malnutrition was very constant and was very striking to all of those concerned in the care of the patient.

*B. Adults (over sixteen years of age), sixty-three cases.*

The foci of infection were notably more wide-spread, and were situated, in their order of frequency, in and about the teeth, tonsils, nasal accessory sinuses, gastro-intestinal and genito-urinary systems, and the mastoids (Table I).

TABLE II  
END RESULTS FOLLOWING THE TREATMENT AND ERADICATION OF FOCI OF INFECTION IN  
100 CASES OF CHRONIC ATROPHIC ARTHRITIS

Age Group	Apparent Cure	Marked Improvement	No Improvement
A. Up to 16 years of age inclusive. . . . .	73 per cent. (27 cases)	16 per cent. (6 cases)	11 per cent. (4 cases)
B. Over 16 years of age (adults) . . . . .	15 per cent. (10 cases)	58 per cent. (36 cases)	27 per cent. (17 cases)

Influence of duration of the disease in the adult group of cases			
1. Under 2 years . . . . .	8 cases	26 cases	8 cases
2. Over 2 years . . . . .	2 cases	10 cases	9 cases

The tabulation shows that the fundamental elements appear to be the duration of the disease and the age of the patient, which determine the favorable reaction to the eradication of foci of infection.

TABLE III

SITUATION OF FOCI OF INFECTION IN 100 CASES OF CHRONIC HYPERTROPHIC ARTHRITIS,  
AND END RESULTS FOLLOWING THEIR TREATMENT AND ERADICATION

1. Single focus group	Dental .....	43 cases
	Tonsillar .....	12 cases
	Paranasal sinuses .....	9 cases
	Gastro-intestinal .....	8 cases
	Genito-urinary .....	6 cases
	Mastoid .....	2 cases
	Total .....	80 cases
2. Multiple foci	Dental, tonsillar, sinus .....	10 cases
	Gastro-intestinal, genito-urinary .....	8 cases
	Dental, gastro-intestinal .....	2 cases
	Total .....	20 cases
3. Results	Apparent cure .....	0 cases
	Marked improvement .....	9 cases
	No improvement .....	91 cases

Eradiation of foci of infection had little or no favorable influence upon the condition.

It was apparent that the favorable response to foci attention in adults depended, in part, upon the duration of the disease and the joint symptoms (Table II). The sooner after the onset of the illness that the foci were treated, the better were the results obtained. In those obstinate cases of long duration, it was assumed that the secondary joint foci themselves were actively operative in the disease. Of the ten adult cases cured, eight were under two years' duration. Twenty-six of the thirty-six that were markedly improved belonged to this same group. Seventeen cases were apparently not influenced at all by the eradication of the foci of infection.

## II. *Chronic Hypertrophic Arthritis* (100 cases)

It was evident that, in the average case, the hypertrophic changes had been present over long periods. In most instances, the onset of the painful symptoms was traced back to mechanical injuries. The ages varied from seventeen to seventy-six years, *most of them having been observed after middle age*. Approximately seventy-five per cent. of the patients were of the laboring class. All of these cases were searched for foci of infection as carefully as were those of the atrophic group.

It was learned that ninety-five per cent. of the patients showed demonstrable foci of infection (Table III). Among the older individuals, the dental foci predominated (sixty-one per cent.). Tonsillar, sinus, gastro-intestinal, and genito-urinary foci were discovered and treated in over half of the cases. Chronic mastoid infections were found in two cases. As far as could be determined clinically, the duration of symptoms did not materially influence the end results in this group. In a few instances, there was definite flare-up of pain in several weeks following the



surgical treatment of the focus, indicating a definite relationship. This period of aggravation was succeeded usually by gradual subsidence of the symptoms, and a return of the joint condition to the pre-treatment stage. In Table III, nine cases are listed as showing improvement.

#### DISCUSSION

The fact that chronic arthritis permits of a relatively simple classification, both clinically and pathologically, indicates the modern tendency to regard its diversified manifestations as chiefly differences of degree. These variations are dependent upon a variety of causes. The condition may be considered, in a general way, as an end-result process, particularly the hypertrophic type, which is usually indicative of long duration. The tissues involved are those of low differentiation, and it is not unusual to find both types of reaction overlapping in the same patient or, what is more convincing, in the same joint. There need be no sharp dividing line between the two great classes. The atrophic and the hypertrophic forms are expressions of opposite ends of the same scale of a single disease. Circulatory disturbances are at the basis of all these infections. The difference in blood supply of the bones and joints at different ages, the vitality of the tissues during the initial invasion, the alterations produced by injuries, and the invasive power of the bacteria may account for most of the infections coming from a focus elsewhere. Practically all of Koch's postulates have been experimentally fulfilled to prove that at least some forms of chronic non-suppurative arthritis are due to bacteria.

It is practically impossible to state definitely by what criteria one may establish the causal relation of a focus of infection in a given case of chronic arthritis. This is further complicated by the fact that a focus must not necessarily be active objectively or subjectively. Many healthy individuals harbor some focus or foci of infection. No less confusing are the secondary interrelationships of multiple foci that may be found in a single individual. It is, of course, necessary first to find the foci. A most diligent and persistent search is often warranted. They are more readily recognized in the superficial subepithelial situations,—as the tonsils. In the gastro-intestinal and, more particularly, the genito-urinary systems the entire field of medicine and surgery may well be challenged. Repeated examinations of the paranasal sinuses and the prostate will often be rewarded. After the foci have been found, their importance in a given case may be determined by such procedures as blood and local bacterial cultures, testing the patient's sensitiveness to the isolated bacteria, and by complement-fixation tests. The clinical evaluation is by far the most important one from a practical standpoint. Finally it may be axiomatically stated that all definite foci that are discovered in a case of chronic arthritis should be treated or eradicated whenever possible, and if the patient's condition permits. The resultant improvement of the general condition which usually follows this is sufficient indication.

In a general way active primary foci of infection are usually above the

vocal cords, while the main secondary foci are found in the tissues below them; the intestinal tract, then, naturally receives the great majority of organisms from above. The foci encountered in this series of cases include the following situations,—tonsils, teeth, paranasal sinuses, ear and its appendages, prostate, intestinal and genito-urinary tracts and associated structures. Most of these have received the bulk of attention in the literature. However, the sinuses have been sufficiently recognized as sources of foci of infection only very recently.

Sinus disease occurs with considerable frequency in certain parts of the country. In some of our cases, especially in younger individuals, the improvement following the treatment of sinusitis has been convincingly demonstrated. We should remember that chronic sinusitis is frequently secondary to chronic tonsillitis, and that the former must be eradicated to insure the best results. As a practical aid in the diagnosis of sinus foci in children, it is essential to note that developmentally the antra are present very early; the sphenoids appear at the age of three, and the frontal sinuses at eight.

In no situation is repeated examination so necessary as in the prostate. It has been shown recently that such foci of infection are very common in adults,—over seventy per cent. according to one author.

It is a significant finding in this series that about eighty per cent. of the cases harbored only one demonstrable focus. This simplified the problem of eradication, but it is felt that some foci were missed, and might account for the less striking results in the adult groups.

The foci in children were more readily recognized, and were certainly less wide-spread and diversified. In many of them the initial joint symptoms could be traced back to the causal acute or chronic focus or foci. In these cases, particularly, the results were sometimes almost spectacularly favorable, following the eradication of the foci. The favorable reaction to foci treatment was most convincing on the whole in those patients under sixteen years of age. The negative influences obtained in the hypertrophic forms may be explained, in part at least, by such factors as age, degenerative changes, duration, and the intrinsic constant injuries these joints are actively subjected to incident to the anatomical deformities present. The term "cure" as used in this paper, indicates a return to the normal clinical state in children. In the adult group it means the same, or arrest of the disease and complete relief of the symptoms.

The joint, especially the synovial membrane of the atrophic variety, must be considered as a secondary focus of infection. Of the seventy or more synovectomies performed in this clinic, the great majority were in cases of atrophic arthritis. Pathological studies clearly indicate the chronic inflammatory nature of the reaction in the tissues excised. Local and systemic relief following this operation is evident. Steindler, in speaking of synovectomy, states, "It is necessary that the disease be localized in one or a few joints only and that the systemic character of the disease has come to an end. Above all things the joint must be in a state of quiescence."

This naturally raises the question of when to operate upon foci of infection. In this clinic it is preferred that the disease should be more or less quiescent before any foci are surgically attacked. This precaution should be observed particularly when the focus is frankly suppurative. Conservative treatment of the focus may be instituted as soon as the diagnosis is made. Some authors believe that the reaction of exacerbation of the joint symptoms that frequently follows the removal of foci acts favorably because of the febrile reaction; but there is also the danger of further dissemination of bacteria to new secondary situations.

Before drawing definite conclusions, it is desirable to emphasize in a general way the systemic and particularly the orthopaedic aspects of the treatment in these cases. Although the generalized nature of chronic arthritis was recognized by orthopaedic surgeons, who were faced originally by its wide-spread deformities, and who urged that the treatment should proceed upon broad general principles, they have realized, nevertheless, that preventive and corrective measures against deformities remain as yet of primary importance. Prevention of deformity is combatted especially in the active stages. When the disease has become quiescent, function is restored by means of appliances and surgery. The local orthopaedic treatment is suggested by the underlying predominant features of the case,—whether they are atrophic or hypertrophic in character.

In the atrophic type the general body mechanics and systems are below par. Improvement may be expected from positional rest periods, exercises, temporary supports, and general hygienic measures.

In the hypertrophic variety the remodeling is obviously harder; but there is less need for general rehabilitation, and mechanical support gives relief.

Because of the basic circulatory deficiency of the joints in chronic arthritis, all measures which tend to increase the blood supply—such as heat, massage, voluntary exercise, and general physiotherapy—are beneficial and sometimes curative in both types. The great comfort derived from the intelligent use of physiotherapy alone indicates its general application in almost every case of chronic arthritis.

Intelligent physiotherapy demands that all such measures be carried out in moderation to avoid fatigue, mechanical strain, or trauma. Further dissemination may be set up by the over-zealous laying on of hands. Many of the older patients are generally run down, and prolonged enthusiastic treatment is more depressing than stimulating. The state of the joints is also an important criterion. Periodic exacerbations of low-grade temperature have been observed in some instances from faulty physiotherapy.

During the active stages of the disease, prevention of deformity and the maintenance of joint motion is accomplished by traction, intermittent use of splints and appliances, and voluntary motion. When ankylosis is imminent, then it should be allowed to become so only in the optimum

functional position. This is especially a threat in the atrophic type and should be a guide in the amount of motion prescribed in such cases. The surgical procedures in the residual stages include aspiration, synovectomy, correction of deformities by closed or open methods, and joint reconstruction by arthroplasty in part or entirely.

The dietary régime followed in these cases is based upon that of Pemberton, and also emphasizes the anticonstipation elements required. High or low caloric values were instituted as seemed necessary.

Elimination was encouraged by colonic irrigations, mineral oil, and mild catharsis.

### CONCLUSIONS

Great emphasis has been placed upon the eradication of foci of infection in the treatment of this series of chronic arthritis cases. The results are at least twenty-five per cent. better than in a similar group in which foci attention was not stressed.

The eradication of foci of infection is of primary importance in children particularly. The results here are most convincing, probably because anaphylaxis is more marked in them. In adults suffering from the atrophic type of chronic arthritis, the beneficial results from foci attention will depend upon the age of the patient and the duration of the disease. The interrelation of foci of infection and chronic atrophic arthritis is almost self evident in many instances. It has been observed, in this clinic, that the focus eradication—for instance, where a focus had caused pain in an apparently quiescent contracted arthritic knee that was undergoing correction by the turnbuckle-cast method—resulted in the cessation of pain and the completion of the correction that would otherwise have been indefinitely postponed or even prohibited.

Foci attention in the hypertrophic types did not materially influence the end results.

Certain foci situations have been emphasized.

Rationalization in the treatment of chronic arthritis demands that the entire field of medical and associated sciences be enlisted.

The orthopaedic aspects of the treatment of chronic arthritis remain as yet of primary importance, but the value of foci attention as one of the associated therapeutic measures should be recognized.

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# ANTERIOR DISLOCATION OF OS LUNATUM

BY G. W. N. EGGERS, B.A., M.D., F.A.C.S., GALVESTON, TEXAS

*University of Texas, Department of Surgery*

## A. EXPERIMENTAL DISLOCATION

The os lunatum, that crescentic, elusive, carpal bone, lies in the proximal row between the navicular and os triquetrum. The dorsal ligament is smaller than the volar attachment to the radio-carpal ligament (Fig. 1).



FIG. 1

Longitudinal section of wrist, showing curvature of head of capitate and anterior and posterior (smaller) ligaments of os lunatum.

The motions of the radio-ulnar-carpal articulations are extension, flexion, abduction, adduction, and circumduction. Rotation of the true wrist (intercarpal) is said not to occur. However, there is motion in the carpal articulations, gliding in type, and rotation must be present to some degree in the capitate-lunate ball and socket type of articulation. The center of rotary motion is through the capitate and lunate which form the main support in that region; therefore, these bones must receive the greater amount of thrust and rotation in abnormal traumatic forces applied to the wrist joint. Figure 2 represents the normal wrist in extension. Note the radius principally in its contact with two bones, the lunate and the navicular. The navicular should be emphasized especially.

Dislocation of the lunate occurs in hyperextension of the wrist joint and pronation of the forearm. The forces applied are hyperextension, a thrust downward, and so called "squeezing out" of the bone, rupturing the posterior and interosseous ligaments. The bone, therefore, rotates distally and anteriorly; and its position is such that the distal articular surface faces anteriorly, and the proximal articular surface, posteriorly. The volar radiocarpal ligament is often injured,



FIG. 2

Hyperextension of hand. Note os lunatum and navicular articulations.



FIG. 3

Anterior dislocation of os lunatum. In this case the bone had perforated the volar carpal ligament.



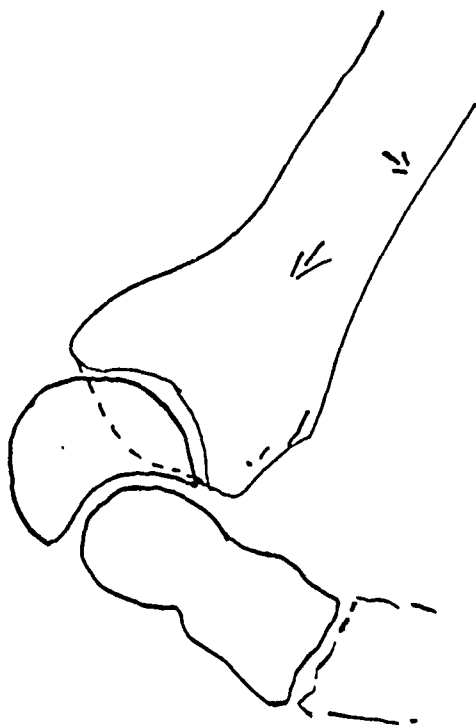


FIG. 4

Distal force causes radius to impinge on capitate as does the hyperextension, rather than slip past it.

and the bone may entirely perforate this ligament. (In one case shown in Figure 3 this condition was verified at operation). The presence of the bone on the anterior carpal surface prevents flexion at the wrist almost completely

and is the important clinical fact in these cases, often not observed.

The etiology of this dislocation has been indefinite, or merely a statement such as "squeezing out". In Figure 4 the hyperextension, with pulling of the radius distally, muscularly, or by external force along the radial axis, is considered. The force to drive the lunate anteriorly is directed against the capitate rather than the lunate. The navicular receives that anterior force. Moreover the posterior ligament of the lunate must rupture. The anterior volar ligament is forcing the lunate into the concave articulation of the radius. To displace the lunate in the cadaver by this method failed.

The second consideration is squeezing the lunate out of its articulation (Fig. 5). The curvature of the lunate, when a force is applied in extension, must be applied by the close-fitting radius, and the natural movement of such force would be to rotate the bone so that the proximal articular surface would move anteriorly. But the pressure is not applied to the lunate only, the navicular sharing in this pressure. It is difficult to understand just how this bone would be so displaced. The anterior

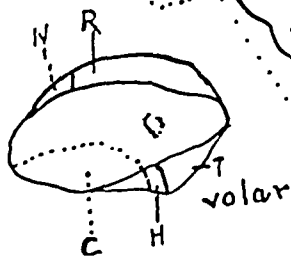


FIG. 5

Rotation by distal radial pressure ("squeezing out") in the circle, an arc of which the curvature of the os lunatum represents, was not possible.

ligament is found intact in the anterior dislocation, and this acts as direct counter pressure full against such a movement. The lunate, separated from both anterior and posterior ligaments, failed to respond when the manoeuver described was performed on the experimental specimens.

Before considering the next manoeuver, it should be noted that the two movements previously described are based on hyperextension, combined with pressure excited in line of the radius distally. The frequency of this indirect trauma to the wrist is shown by the great number of fractures of the distal end of the radius. To dislocate the bone, the methods here described take for granted an extremely elastic volar ligament. This would certainly be likely in children with their youthful ligaments. However, practically all of the lunate dislocations are in adults in whom the elasticity of the ligament is less. It is my belief that the dislocation is more complicated than the simple descriptions given.

It is necessary to note certain facts in describing the next possibility of dislocating the lunate. The capitate and lunate form the bony column to receive distal thrusts. The lunate and capitate form an almost ball and socket joint, at which any intercarpal rotation may occur, granting the interosseous ligaments restrict it. If by force these ligaments should break, then intercarpal rotation would tend to occur at the lunate-capitate articulation. The lunate is firmly held by the radius, inducing the greatest motion at the lunate-capitate joint. The triquetrum is held firmly in place by the flexor carpi ulnaris through the pisiform. In hyperextension of the wrist the flexor carpi ulnaris tends to broaden the interval between the capitate triquetrum and hamate. The arc of curvature of the capitate is greater posteriorly, which may allow it to slip past the lunate easily.



FIG. 6

Forearm in extreme medial rotation; the pisiform and triquetrum removed. Volar carpal ligament and posterior ligament of os lunatum divided. Note how os lunatum slips past head of capitate in interval described.

With these facts in mind, the mechanics of the dislocation would be hyperextension of the wrist with hand fixed; then medial rotation of the forearm, which continues until pronation reaches the maximum of radio-ulnar rotation; the medial rotation continues; then the intercarpal rotation starts between the capitate and lunate. As this is forced, the interosseous ligaments are stretched or broken, the lunate rotates medially until it passes the anterior edge of the capitate which slips proximal to it (Fig. 6). The lunate has a wedge-shaped area on the dorsal surface directed toward the hamate, which tends to slip between the hamate and capitate; for this interval is increased by the medial rotation opposed by the flexor carpi ulnaris. As the abnormal force subsides, lateral rotation of the forearm occurs in hyperextension, and the flexor muscles pull the carpal bones proximally. By this manoeuvre, the lunate is now forcefully ejected anteriorly; breaks the weaker posterior ligament; and is rotated proximally and anteriorly into the usual position of dislocation by its anterior ligament. By dividing the posterior and interosseous ligaments, the dislocation can be accomplished on the cadaver by the application of the manoeuvres described. (The manoeuvre may be described by fixing the forearm and rotating the hand, in which case the directions of rotation are reversed.)

While it is realized that there is no limit to the combination of abnormal physical forces in trauma, nevertheless this explanation of dislocation is offered. Surely its rarity is somewhat in keeping with the experimental findings on the cadaver.

#### B. SURGICAL APPROACH

The diagnosis is not difficult if the x-ray is used. Clinically the flexor tendons are prominent; there are pain and tenderness in the wrist joint and particularly inability to actively or passively flex the wrist. True, some of these dislocations are diagnosed as sprains, but that is another topic. The treatment is reduction of the dislocation or removal of the lunate. Reduction of the dislocation has been considered in the articles by Davis<sup>20</sup> and Böhler<sup>6</sup>. However, it seems that reduction is sound judgment,

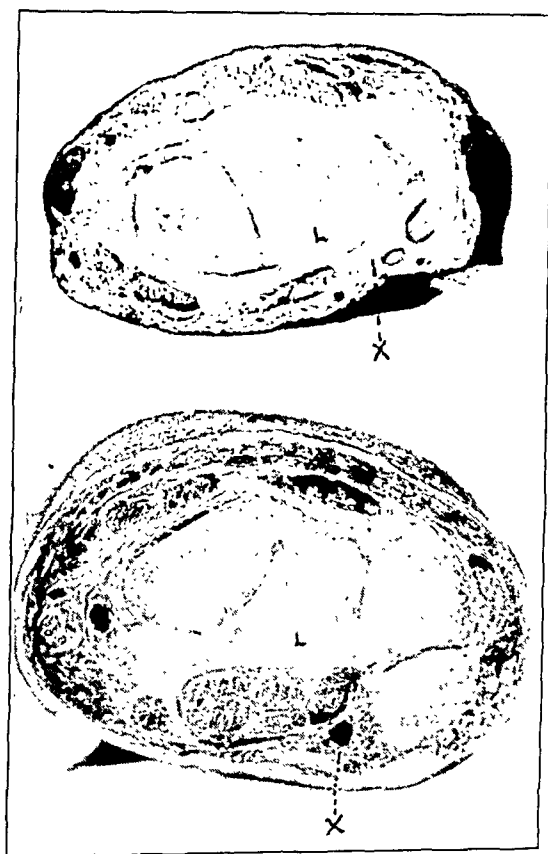


FIG. 7

Cross sections of wrist. X—The fibrous-tissue layer between the flexor carpi ulnaris and flexor group of hand. L—Os lunatum.

because the anterior ligament certainly is usually sufficiently attached to furnish a satisfactory blood supply.

To remove the bone several surgical approaches are possible. The usual posterior approach is such as to be extremely difficult and easily allows fragments of the bone to remain. The anterior mid-line approach is through the flexor tendon sheaths and near the median nerve. The objection here is tendon-sheath damage and adhesions to the skin of the tendon-traversed areas.

A third possibility is to approach the bone lateral or medial to the flexor tendon sheath. However, since the lunate is medial, this eliminates the lateral approach.

This medial approach is found to be satisfactory. Figure 7, a cross section of the wrist, shows the fibrous tissue pathway leading from the surface of the wrist, between the flexor tendons and the flexor carpi ulnaris with the ulnar nerve and artery. This leads down to the anterior carpal ligament; incision of the ligament is necessary for removal of the bone.

The method of this approach, with asepsis given all proper consideration is as follows: Incision is made two and one-half inches long just lateral to the flexor carpi ulnaris, starting one-half inch distal to the pisiform bone and extending proximally. The skin is incised; sometimes a small superficial vein needs ligation. Then by blunt dissection the ulnar artery and nerve are easily identified and retracted medially (the flexor carpi ulnaris prevents trauma by stretching). The flexor tendons are lifted anteriorly and laterally and the volar carpal ligament is visible. The bone is in the distal end of the incision. The ligament is divided transversely and retracted, and the lunate removed. Since the anterior ligament (the anterior surface of the dislocated bone is rotated cephalward) holds the lunate, division releases it readily for removal. After being released the carpal ligament is readily approximated and, when traction is removed, all structures assume their anatomical position. Closure of the skin is now necessary. A light plaster splint is placed dorsally for comfort.

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## THE TREATMENT OF OSTEOMYELITIS

BY CHARLES LYLE HAWK, M.D., M.S.C., LOS ANGELES, CALIFORNIA

The classical description of inflammation characterizes it as presenting calor, dolor, rubor, and tumor. This is true of soft tissue where these features are present, but bone tissue is rigid, and the tumor or swelling is necessarily absent, although the heat, pain, and redness may be present. The inflammation causes an exudate, forming a defensive barrier, which requires room for expansion so that the exudate can accumulate the defensive materials,—therefore the swelling. When the process develops in bone tissue, the necessary exudate causes the barrier to be forced back into the rigid channels. It is readily seen that in an acute process rapid and often unabated destruction of bone takes place. Trendell says that bacteria of bone infection are always virulent. In case the organism becomes attenuated and the process is halted, and nature is left unaided, a chronic bone abscess continues to discharge for years, for no other reason than because of its location in rigid tissue which will not expand and allow of defensive and reparative efforts sufficient for healing.

Inflammation is described by Adami as the condition into which tissues enter as a reaction to irritation. This reaction in bone infection means efforts at destroying the bacteria, neutralizing the bacterial toxins, removing the necrosed debris, and repairing the tissue defect. The purpose of treatment must be to aid nature in fulfilling these functions. Any form of treatment that stimulates the exudate and neutralizes the agencies which are harmful to repair is to be desired. This implies more than simple protection to the wound. It means a stimulant to the exudative process and a provision for free and open drainage and hygienic measures that will augment the blood supply to the part. The late William Baer was the author of successful mechanical hyperaemia, but some form of chemical hyperaemia is desired in bone infections. We, therefore, use the principle of osmosis to hasten the healing of bone wounds and to care for the infection present. Some solution with high osmotic action, whose solute has a high valence with active ionization for the precipitation of colloids and destruction of bacteria, is desired. It should be non-toxic to viable tissue and not too irritating to sensory nerves.

According to Mathews<sup>1</sup> the necessary concentration to precipitate colloids is 21.3 for calcium chlorid, 34.1 for magnesium sulphate and 16.4 for magnesium chlorid. These are bivalent salts, while sodium chlorid is monovalent and requires a relative concentration of 1680. According to A. A. Green<sup>2</sup> sodium sulphate is second in the order of decreasing precipitating power among a list of salts given, magnesium sulphate is fifth, and sodium chlorid is seventh. The precipitating power of a salt varies with the valence and the readiness with which it ionizes. As the ions appear to be electrical charges associated with the valence of the salt,

bivalent salts have a much higher precipitating power than the monovalent, the trivalent being still more powerful. Also, the heavier the metal, the greater the precipitating power. The specific gravity of sodium is 0.972, of magnesium, 1.75. Whetham computed that an ion with two or more electrical charges attached—*i. e.*, a bivalent or trivalent ion—has far greater chances of coming into contact with the colloid and precipitating it. The ions alter the surface contact of the colloids with water and cause them to accumulate into clumps and precipitate. Magnesium ionizes better than sodium, though the latter has greater internal energy as a metal. Also, the ionization of the sulphate radical is greater than that of the chlorid radical. Magnesium sulphate was, therefore, chosen as the salt most desirable for our purpose.

The formation of exudates is accomplished largely by the action of osmosis, and the equilibrium is governed by the relative concentration of the fluids inside and outside of the capillaries. These vessels ordinarily allow only the serum globulins, crystalloids, and smaller structures to pass through the walls. Injury will allow the albumins to pass, and sometimes in such quantities as to render the concentration outside equal to the plasma albumin.<sup>3</sup> The capillary walls are rendered more pervious by inflammation in direct ratio to the intensity of the infection. This seems to be nature's way of increasing the exudate, in the absence of artificial means. But by adding to this the powerful effects of a high osmotic fluid, the exudate is much increased and the granulations spring up most abundantly. The forceful exosmotic action eliminates the toxins and markedly reduces the number of bacteria present. For repair of bone tissue, the same process is followed as occurs in the formation of membranous bone in the foetus. The type cell is the fibroblast, and the proliferation of this cell, together with endothelial cells, forms very vascular connective tissue, which becomes osteoid in character. Trabeculae of this tissue thicken and fuse and receive deposits of lime salts.<sup>4</sup> It is obvious that such procedures are augmented by increasing the exosmotic flow and are only hindered by unabsorbable packs filling the defect, thus preventing adequate drainage,—especially when the dressing is left in indefinitely, causing a back pressure of the accumulated pus.

So many of our osteomyelitic cases are either old cases with labyrinthine sinuses or cases where, because of anatomical design, the process cannot be wholly eliminated mechanically, that one must resort to physico-chemical means to secure the desired result. It is obvious, therefore, that to hasten the healing of a wound and to diminish absorption, it should be filled with a solution, capable of exerting a high osmotic pressure, which will accelerate the formation of an exudate and also exert antiseptic action on the infection, without injury to the viable tissues. Exosmosis, and the precipitating action of ionized salts on the bacteria, will accomplish this end.

Much has been said about the drainage of infected tissues. Dead protoplasm is acid, and, if the wound is left filled with an acid débris, it

causes a diminution of oxygen tension in the granulation tissue cells and excites the autolytic enzymes in the cells to dissolve the protoplasm. Acid causes swelling of tissue cells and this has the effect of pushing deeper into the bone canals the barriers that have been set up. In the practice of treating the wound by plugging with vaselin gauze, it has been urged that drainage is of prime importance. But for adequate drainage to be secured in a rigid bone wound plugged with vaselin—a substance non-miscible with water—and the part then enclosed in a plaster case for an indefinite period, is more than the writer's imagination can encompass! We, therefore, advocate frequent dressings, in order to keep the wound clean and to replenish the exosmotic fluids. In case bacteriophage may be considered to play a part in those forms of treatment which involve plugging the bone with a non-absorbable substance, it is well to bear in mind the fact that phage respire, during its destruction of bacteria, absorbing oxygen and emitting carbon dioxide. Even in test-tubes the bacteria are lysed in from three to five hours, when the broth culture is shaken to increase the oxygen tension; the unshaken tubes require from eight to twelve hours.<sup>5</sup> Truly, with the wound plugged, little respiration can take place. Phage is often found in a wound, but is usually not lytic to the wound bacteria,—living there in symbiosis.<sup>6</sup> Purulent material, exudate, blood, and diluted serum are all inhibitory to the lytic action of phage, even in dilutions of 1:1000.<sup>7</sup> These findings necessitate continuous cleansing of the wound, if phage is to play any part in the sterilization and healing. Kreuscher and Hueper tell us that the healing of bone is delayed in direct ratio to the infection present.<sup>8</sup>

The procedure which the author follows is first to evacuate all the dead and pus-infiltrated bone, regardless of its extent, the only limiting bounds being the epiphyseal discs in the young, and the sparing of sufficient bone in the shaft to maintain strength. Unless the whole bone is destroyed, one can usually provide ample drainage by chiselling away only one-third of the cross section of the shaft. It is not necessary to make an extensive saucerization; but the outer width should be greater than the basal diameter, so that the latter will close first by granulations. The time of operation is—as the late J. B. Murphy said—as soon as osteomyelitis is diagnosed.<sup>9</sup> With the high-osmotic dressing, the surface fluids are immediately drawn into the wound, instead of being allowed to be absorbed by plugging the cavity with a non-absorbable substance. It is well, in acute cases, to swab the wound with tincture of iodine. The surface of fractures and of chiselled bone dies, even in closed fractures, and one must expect to find thin layers of dead bone floating on the granulations after one or two weeks; so a mild cauterization of the denuded areas with iodine will do no harm. After the mechanical work is done and the wound treated as described above, it is packed with gauze, well impregnated with a paste made of one part glycerol and two parts magnesium sulphate. The gauze serves as a wick, when the paste is thinned by absorption of blood and exudate. The wound does not have to be



completely dried, but the spurters should be closed with bone wax. The paste should be prepared beforehand with incorporated layers of gauze and the whole autoclaved. In case the wound is small, it should be filled with paste and the gauze laid on top. An ample amount of the paste is placed over the gauze covering the wound, and the whole enclosed in an oiled-silk dressing, which should be snugly bandaged to the limb. There will be some oozing which will wash the wound and bring blood to the part, while the paste solution prevents any reabsorption.

In case one is unable to remove all the diseased tissue from an old case, or in an acute fulminating one, the dressing should be changed in from four to seven days, depending upon the temperature. As soon as the temperature goes up, it means absorption with the dilution of the paste to a hypotonic solution. The amount of oozing following operation will influence this very markedly and, therefore, it is best to wrap the limb well with oiled silk and, if necessary, to cement the edges with collodion to hold the fluids until thrombosis of the vessels takes place. A hypodermic should be given before the first and sometimes before the second dressing, because the removal of any gauze incorporated in granulations at this time is very painful. The pus is removed by pouring peroxid of hydrogen into the cavity. This has the highest interfascial tension of any non-metallic pure fluid at room temperature,<sup>10</sup> and this is ideal for removing pus and débris without injury to the granulations. The foam and remaining liquid is removed by a pledget of absorbent cotton, not gauze. The cavity is again packed with the paste and gauze as before and the same dressing applied. In comparatively clean cases the dressings should be changed twice weekly. In badly infected cavities it should be changed every second day. There is practically no odor unless the lesion is in a place where the dead tissue could not be completely evacuated, as in osteomyelitis of the upper end of the tibia. All the diseased bone that can be removed safely without danger of involving the joint should be evacuated, and the subsequent treatment trusted to remove the remainder. The granulations will be so abundant that pieces of non-viable bone will be seen floating near the surface.

In regard to immobilization—a point which has been stressed so vigorously by Orr <sup>11</sup>—we have emphasized that bone tissue is rigid, and any infection therein is splinted by nature to the *n*th degree, the only alteration that an enclosing plaster case can accomplish is to render the circulation more sluggish, and thus to interfere with healing. We advise getting the patient on his feet as soon as he has recovered from the mechanical work in the operating room, providing enough bone has been left to support the limb. For this reason the author advises making the excavation long and narrow, first, to retain strength in the shaft and, second, because the cavity will heal more quickly if the granulating sides are not separated too far. Bone is viable tissue, and living tissue increases its vitality with use. Not all of the bone is diseased, and the resistance of the viable part to the infection will be raised by use. Using

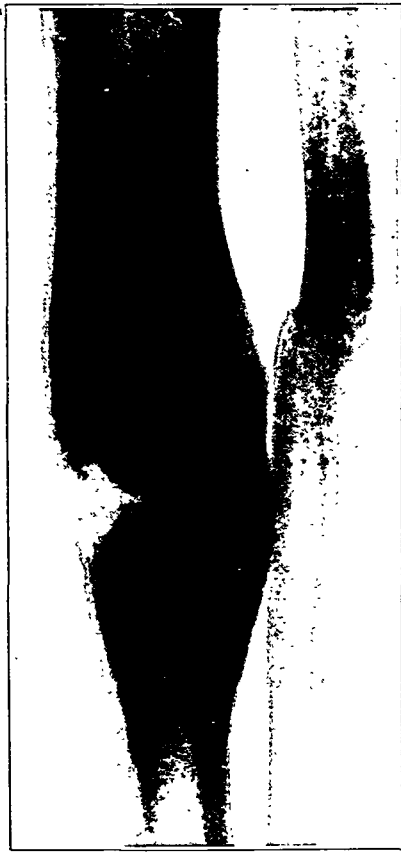


FIG. 1

Case 1. Before operation.

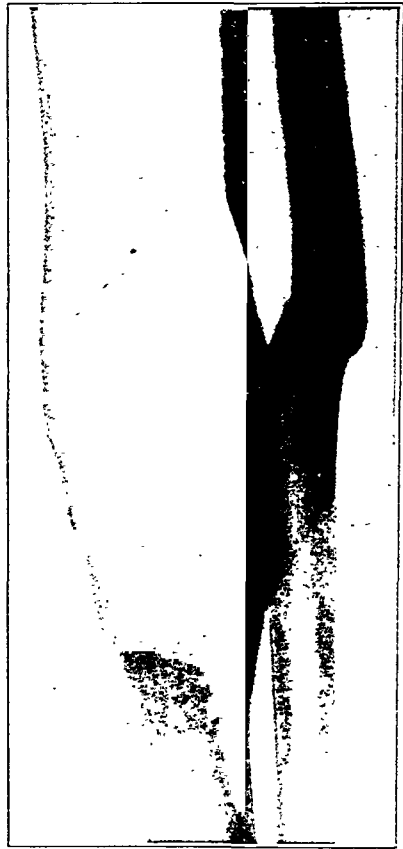


FIG. 2

Case 1. Six weeks after operation.

a bone increases the blood flow, mobilizes calcium, and stimulates the part to meet the demands placed upon it. The x-ray shows absorption of calcium after one week in a limb that is immobilized for any cause, and this proves the delicate balance, to which bone is sensitive, between use and non-use. It has been found by animal experimentation that ligating return veins in cases of arterial damage lessens the frequency of gangrene in the limb. Intracapillary tension is necessary for proper nutrition and the use of a limb in a dependent position increases both the blood pressure and the hydrostatic capillary pressure. When one views a patient lying in bed week after week, with the involved part enclosed in a cast, and absorbing putrefactive products from the wound, with a sluggish circulation from no exercise, one is not surprised to see him sallow and toxic in appearance, and what little appetite he may have diminished by a foul stench! The author has seen this picture only too often: the wonder is that the patient gets well at all.

If the soft tissues about the bone are involved, as may happen in a gunshot wound, the musculature must be kept quiet until ample soft-tissue

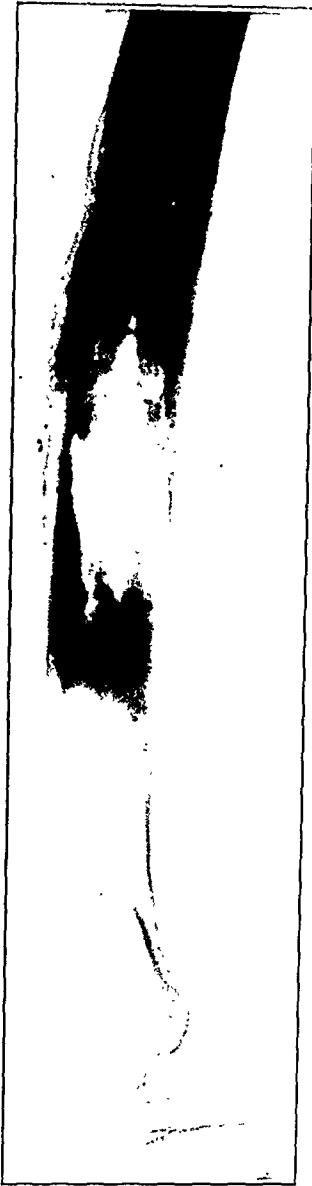


FIG. 3

Case 2. Lateral view twenty-three days after operation.

barriers are formed. In such a case some exercising apparatus should be rigged to the bed for the use of the sound limbs, to maintain the general vitality and force of heart action. Also, in all cases, healing is assisted by dry heat treatments. It is reported that protoplasmic activities are increased two or three times by a rise of ten degrees in temperature. The efficacy of thermal therapy is unquestioned.

Two typical cases are presented.

CASE 1. B. R., white, male, aged forty-five. Patient entered the hospital in November 1928, with a compound, comminuted fracture of the right leg. In March 1930 the roentgenogram showed healing of the fractured bones with some residual infection and a draining sinus. Patient was first seen by the writer September 18, 1931, with a small sinus leading into the bone at the site of the fracture. At operation, September 19, 1931, a small sequestrum was removed and a quarter inch of sclerosed bone was removed from around the sinus. The cavity was

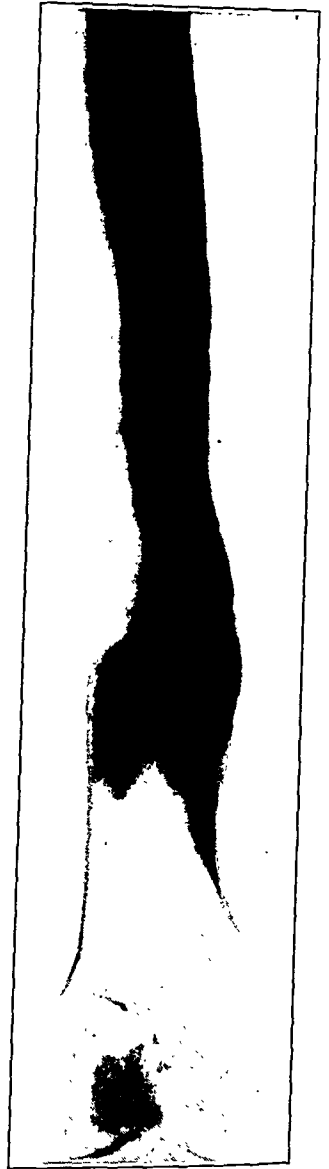


FIG. 4

Case 2. Anteroposterior view twenty-three days after operation.

filled with magnesium sulphate paste and gauze, with more paste placed on top and wrapped in oiled-silk dressing. Dressing was changed on fifth day and bi-weekly thereafter. Patient was allowed up on crutches six days after operation. Wound was healed six weeks later.

CASE 2. M. R., white, male, aged twenty-three. He had accidentally shot himself in the thigh in 1929 and had improved until May 1930 when, while at work, he accidentally injured himself at the site of the old injury. He was operated on September 6, 1930, and again in February, 1931, and the wound was "packed with paraffin and vaselin gauze". He was again operated on in June 1931, and an "Orr pack with cast from groin to toes" applied. Patient was first seen by the author on August 28, 1931, at which time the roentgenogram showed "a large part of the shaft of the femur consistent with osteomyelitis". There was a discharging sinus in the site of the old scar, eight inches long, on the outer aspect of the thigh.

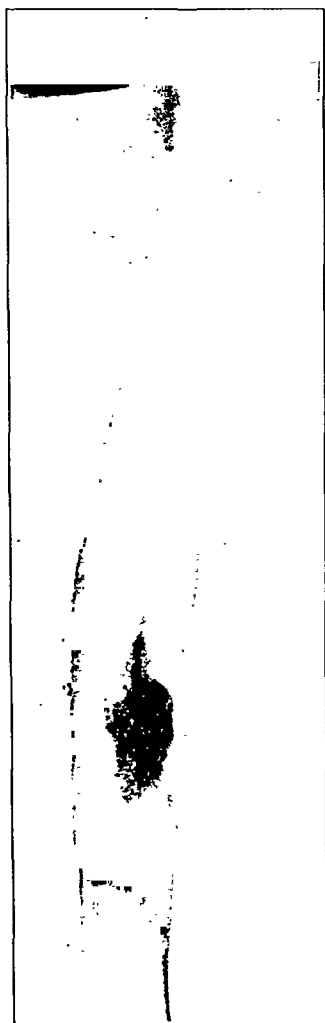


FIG. 5

Case 2. Showing lateral view of femur fifteen weeks after operation.

At operation September 5, 1931, the entire outer one-third of the cortex of the femur was removed for a distance of eight inches. The cavity was then packed with magnesium sulphate and glycerin paste and gauze and the limb enclosed in a water-proof covering and bandage applied. The patient was last seen on January 11, 1932, in the Out-Patient Department, at which time the wound was almost healed. This patient had had two flare-ups from the infection in the soft tissues which confined him to bed for short intervals. This case is reported to illustrate the rapid regeneration of bone in the extensive cavity which was infected and sclerosed in obscure areas. We believe that the physical exercise practised by this patient helped to clear up the old latent soft-tissue infection as well as to stimulate bone growth.

The early exercises must not be mild, else the soft-tissue barriers will be broken down and the infection spread, as is well known.

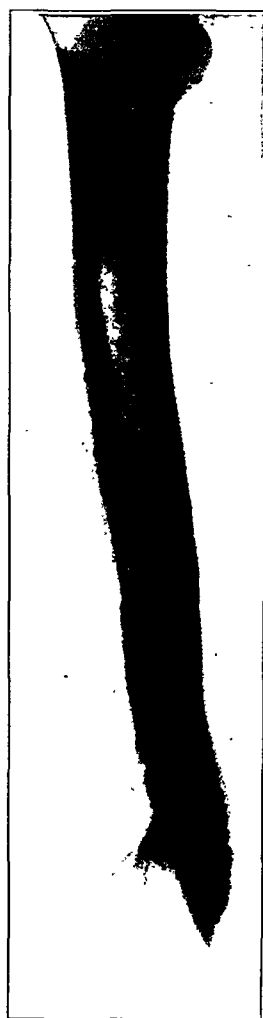


FIG. 6

Case 2. Anteroposterior view fifteen weeks after operation.

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# THE RÔLE OF SURGICAL MAGGOTS IN THE DISINFECTION OF OSTEOMYELITIS AND OTHER INFECTED WOUNDS \*

BY WILLIAM ROBINSON, PH.D., AND VERNON H. NORWOOD, M.D.,  
WASHINGTON, D. C.

One of the characteristics of the Baer maggot treatment is a marked reduction in the infection of the wound. Baer<sup>1,2</sup> noted an unusual decline in the number of bacteria present in the wound when maggots were used, and he described maggots as a "viable antiseptic". Confirmation of his results has appeared in the extensive literature on the subject of the maggot treatment.

An investigation has been made of the manner in which disinfection is brought about. A discussion of results follows, with details of the experiments omitted in this article.

## DESTRUCTION OF BACTERIA BY DIGESTION

When maggots are implanted in an infected wound they feed upon the necrotic and purulent materials present and, at the same time, take up large numbers of bacteria. The digestion of such bacteria is one means by which maggots could reduce wound infection. To determine the fate of ingested bacteria, observations were made of their progress through the alimentary tract. Maggots which had fed within osteomyelitis wounds for one to two days were dissected aseptically. Portions of the intestine and the tubular "stomach" were removed and cultured bacteriologically.

In all of the specimens dissected abundant bacterial growth was obtained in cultures from the "fore-stomach". On the other hand, no growth whatever was observed in any of the cultures from the intestine. An intermediate area called the "hind-stomach" showed slight growth in one-third of the cases.

A progressive destruction of the ingested bacteria was, therefore, found to take place in the alimentary canal. The sterility of the intestine is evidence that the bacteria are destroyed in the stomach.

In a study of the nutrition of blow-fly larvae, Hobson<sup>3</sup> found proteolytic enzymes in the fore and hind portions of the stomach, activity being especially marked in the hind section. The digestive effect of these enzymes may explain the destruction of bacteria in the stomach. It is significant that the hind stomach, where the decrease in numbers of bacteria is most evident, is the section with greatest enzymic activity.

Some tests were therefore made of the ability of these enzymes to destroy such bacteria as streptococcus hemolyticus and staphylococcus

\* Contribution from the Division of Insects Affecting Man and Animals, Bureau of Entomology, United States Department of Agriculture, Washington, D. C., and the Pathological Laboratory of the Church Home and Infirmary, Baltimore, Md.

aureus, commonly found in the osteomyelitis wound. The digestive enzymes of the maggots were obtained by macerating sterile maggot tissue, consisting principally of alimentary tract. This was then inoculated under various conditions with the bacteria mentioned. All subcultures showed abundant growth; and no evidence was obtained, even with the lightest inoculations and the longest periods of contact, of any destructive effect. In view of the fact that such bacteria are destroyed within the maggot, the negative results obtained may be due to the death of the enzyme-secreting cells during maceration.

These results differ from those reported by Livingston<sup>4</sup>, who states that "paste made from the dead bodies (of maggots) is also effective as a curative agent"; and from the results reported by Livingston and Prince as follows: "filtered, uncontaminated products derived from the bodies of larvae in culture, when brought into contact with pyogenic organisms in petri dishes, destroyed the cultures". Also, in his report<sup>4</sup> of one hundred cases of infected wounds in which he used the maggot treatment, Livingston observes that, "If the wound was clean and the discharge moderate or slight after the third application (of maggots), the use of live maggots was discontinued, and gauze packs saturated with active principle were introduced daily until healing was accomplished, or until the discharge again increased in amount. If the discharge again became profuse, maggots were reintroduced from one to three times." Under this method of treatment any healing effect of an "active principle" or maggot extract is not readily evident.

#### REMOVAL OF NECROTIC TISSUE AN AID TO WOUND DISINFECTION

It is recognized that necrotic tissue remaining in the wound favors increased infection as well as absorption of toxic substances. Myers and Czaja<sup>6</sup> have shown the difficulty or impossibility of complete elimination of all such tissue surgically. Furthermore, additional necrosis frequently occurs.

Maggots feed voraciously upon the devitalized and purulent materials which accumulate within the wound, and are usually found in such areas. The amount of necrotic material which each implantation of maggots is capable of removing is surprisingly large. An average implantation will consume as much as ten to fifteen grams. This is augmented by further implantations every four or five days. Maggots, therefore, aid in cleaning up the wound by penetrating necrotic areas, suitably opened up, and feeding therein, thus making the condition of the wound less suitable for bacterial growth.

#### SECRECTIONS A FACTOR IN DISINFECTION OF THE WOUND

During maggot treatment the wound is stimulated to secrete a thin, serous discharge in comparatively large quantities. This is heavily contaminated and carries off numbers of the pathogenic organisms of the

wound. Such drainage, which continues as long as maggots are present, becomes a significant factor in hastening disinfection of the wound.

#### LIVING MAGGOTS APPEAR NECESSARY IN TREATMENT

The effects obtained in this investigation have all been the result of the direct activities of living maggots. Mixtures of macerated maggot tissue gave negative results in cultures. The removal of necrotic tissue, which is important in treatment, also requires living maggots. The presence of active maggots in the wound, therefore, appears to be a prime requisite in treatment.

This differs from the view-point expressed by Livingston and Prince<sup>5</sup> who reported that a maggot extract was "in itself a curative agent". The use of such an extract in wounds, whereby maggots could be eliminated, would be very desirable. However, data sufficient to prove the effectiveness of these mixtures have not yet been given.

#### DEVELOPMENT OF GRANULATION TISSUE

The abundant growth of granulation within the wound is one of the outstanding characteristics of the maggot treatment. This growth is sometimes regarded as the result of a stimulation by maggots. In view of the present investigation, it seems possible that the increased growth may not be altogether due to actual stimulation. Where maggots are not used in treatment of chronic osteomyelitis, there is likely to be a greater amount of necrotic tissue present and a higher infection. Such conditions may produce sufficient toxins to prevent the natural growth of granulation. Under the maggot treatment, with its more rapid cleaning up of the wound, the tissue may be free to grow spontaneously at its normal rate; and, in contrast with the usual rate, may appear to be a stimulation.

#### SUMMARY

When used in infected wounds, the surgical maggots are able to hasten disinfection. A study has been made of the means by which the destruction of bacteria has been brought about. Maggots ingest bacteria in large numbers in feeding upon the necrotic tissues of the wound. Cultures of aseptic dissections of the alimentary tract of maggots showed an abundance of bacteria in the fore-stomach, decreasing numbers in the hind-stomach, and apparently a total disappearance of the bacteria in the intestine. This indicates that ingested bacteria are destroyed in passing through the alimentary tract.

To determine whether or not destruction is caused by digestion, tests were made of the action of digestive enzymes of maggots upon streptococcus hemolyticus and staphylococcus aureus. The enzymes were obtained by maceration of sterile maggot tissue. Results were negative in all cases. This is probably due to death of enzyme-secreting cells during maceration. Livingston and Prince report positive results and



state that applications of maggot extract were effective as a curative agent. The data, however, do not make clear how the healing effect obtained was due to maggot extract. Repetition of our tests confirm our negative results.

Maggots feed upon the necrotic and purulent materials within the wound. They thus aid in cleaning up the wound and making its condition less suitable for bacterial growth.

Drainage from the wound is stimulated under maggot treatment. The excessive discharge, which is heavily contaminated with bacteria, assists in wound disinfection.

This investigation indicates that the effects obtained in the maggot treatment of infected wounds are due to the action of living maggots in the wound, and that living maggots can not be eliminated in treatment.

The increased growth of granulation tissue within the wound and its relation to maggot activities is discussed.

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# ASEPTIC NECROSIS OF THE HEAD OF THE FEMUR FOLLOWING TRAUMATIC DISLOCATION OF THE HIP JOINT

## CASE REPORT AND EXPERIMENTAL STUDIES \*

BY WILLIAM J. STEWART, M.D.\*\* , CHICAGO, ILLINOIS

Traumatic dislocation of the hip in adults is a not infrequent accident. In the great majority of instances, the hip joint returns to normal within a few weeks after reduction of the dislocation and there are no subsequent changes in the head of the femur. That quite startling changes may occur after dislocation is illustrated by the following case reported from the University of Chicago Clinics.

### CASE REPORT

R. B., male, aged twenty-two, was admitted to the University of Chicago Clinics complaining of pain in the right hip, associated with a limp and inability to bear weight upon the right leg.

Twelve months before his admission on December 27, 1930, the patient was in an automobile accident from which he suffered a simple dislocation of the right hip, as shown by a roentgenogram (Fig. 1) and minor bruises and lacerations. The dislocation was reduced within a few hours and the leg put in a spica cast. A roentgenogram through the cast confirmed the reduction. The patient thought that during the first week or so, "he might have had some slight fever", but he was uncertain about this. A roentgenogram taken one month after the accident showed no change in the joint (Fig. 2). After six weeks, the cast was removed and he was permitted to walk with crutches. He gradually increased his activity and, after three months, walked with a cane. The range of motion in the hip was restricted, but it gradually improved and the pain lessened. After five months, the pain and stiffness gradually increased and two months later he had to resort to the use of two canes in walking.

Figure 1, a roentgenogram taken December 27, 1930, shows the head of the femur riding above the acetabulum. The head is smooth and of even density. There are no fracture lines in the neck or upper third of the femur and the acetabulum appears normal. A film taken immediately after reduction showed the head of the femur in the acetabulum and normal relationships of the hip joint reestablished.

Figure 2, a roentgenogram one month later, January 26, 1931, shows the head of the femur in the acetabulum. There are two lines in the course of the weight-bearing portion of the acetabulum which are apparently cast by different portions of the curved articular cortex. There is slight clouding of the lower part of the acetabulum.

Nine and one-half months after the dislocation, September 10, 1931, a roentgenogram (Fig. 3) was taken which shows disappearance of the cartilage space and some of the substance of the head in the weight-bearing portion of the joint. There is some reduction in density of the remaining weight-bearing portion of the head. There is a cloudy increase in density in the region of the mesial portion of the head. The head is flattened and irregular. There are two cloudy, oval shadows in the region of the capsule just below the superior acetabular margin. There is regional bone atrophy.

\* From the Division of Orthopaedic Surgery, Department of Surgery, University of Chicago. This work was done under a grant from the Douglas Smith Foundation for Medical Research of the University of Chicago.

\*\* Thesis submitted to the Faculty of Orthopaedics of the Graduate School of Medicine of the University of Pennsylvania in partial fulfillment of the requirements for the degree of Master of Medical Science [M.Sc. (Med.)] for graduate work in Orthopaedics.



FIG. 1

Before reduction.

The patient continued to walk with canes, and another roentgenogram (Fig. 4) was taken ten and three-quarters months after the injury, which shows the loss of the cartilage space and the disappearance of the substance of the head and weight-bearing portion of the joint previously noted. The two oval shadows in the superior portion of the joint capsule are more pronounced and resemble new bone formation. In addition, there is a similar process in the inferior portion of the capsule. There is increased density of the mesial portion of the head, but the loss of density of the weight-bearing portion of the head is not so pronounced.

One year after the injury, when the patient was examined, he complained of considerable pain on walking, which was accomplished with the aid of two canes. Physical examination revealed a large, muscular, well developed man of twenty-two, not acutely ill. Regional examination was essentially negative aside from the right hip and leg.

There was definite atrophy of the muscles of the entire right leg. Hip flexion was limited to about forty-five degrees. The thigh was abducted about ten degrees. Abduction, adduction, and rotation were markedly limited. Forced movements of the hip were somewhat painful. There was no tenderness on pressure over the joint. A roentgenogram (Fig. 5) December 26, 1931, showed no marked change from the film made one month before.

The diagnosis at this time was as follows:

1. Old traumatic dislocation of the right hip, reduced.
2. Rupture of the ligamentum teres and interference with the blood supply of the head of the femur.

3. Aseptic necrosis of the head of the femur with subsequent breaking down of the weight-bearing portion of the head from usage.
4. Ossification of the capsule of the joint.
5. Destructive traumatic arthritis of the acetabulum.

*Treatment:*

Under ethylene anaesthesia, the hip was abducted about forty-five degrees and a body and right thigh spica cast was applied. Two months later the cast was removed. Motion at this time was painful and limited to ten degrees' abduction, ten degrees' adduction, twenty degrees' flexion, and ten degrees' rotation.

The patient was confined to bed and traction was applied to the leg for two hours twice a day with resultant relief of pain. After three weeks of this treatment, motion was limited to ten degrees' flexion, ten degrees' rotation, five degrees' abduction, and five degrees' adduction. A roentgenogram was taken at this time, March 18, 1932 (Fig. 6). The density of the mesial portion of the head was very marked and there was also increased density of the acetabulum above the weight-bearing portion of the head.



FIG. 2

One month after reduction, through the cast.



FIG. 3

Nine and one-half months after reduction, showing beginning breaking down of the head.

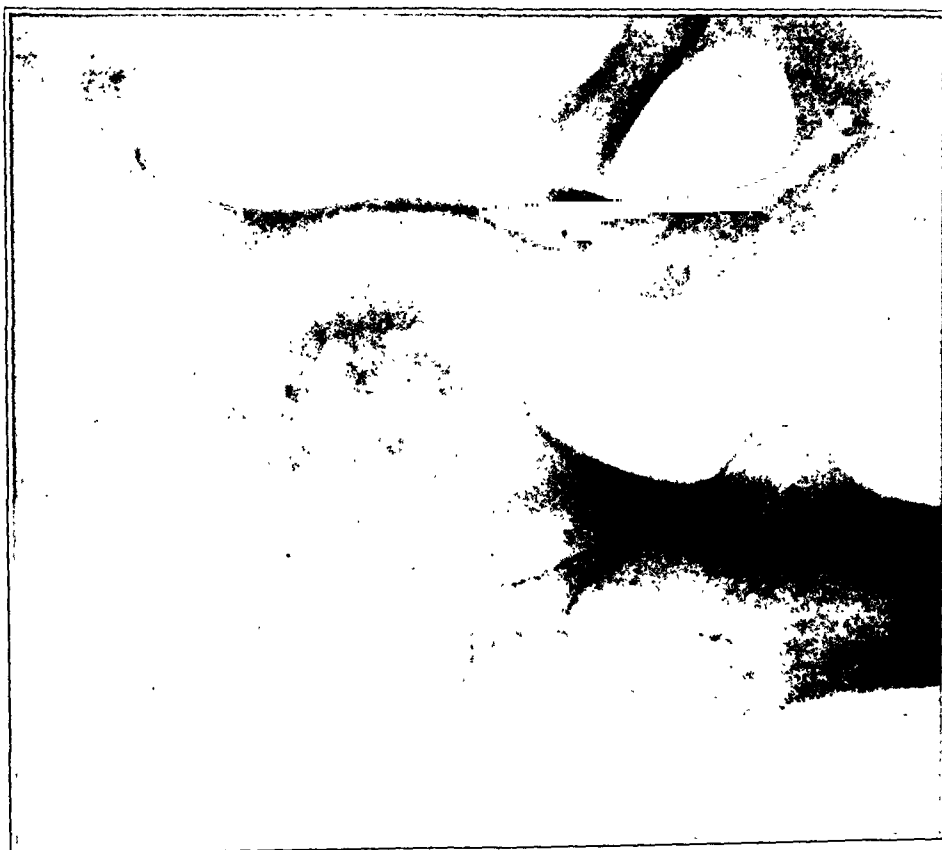


FIG. 4

Eleven months after reduction, showing ossification of the capsule and more breaking down of the weight-bearing portion.



FIG. 6

Fifteen months after reduction, showing increased ossification of the capsule and rounding of the head.

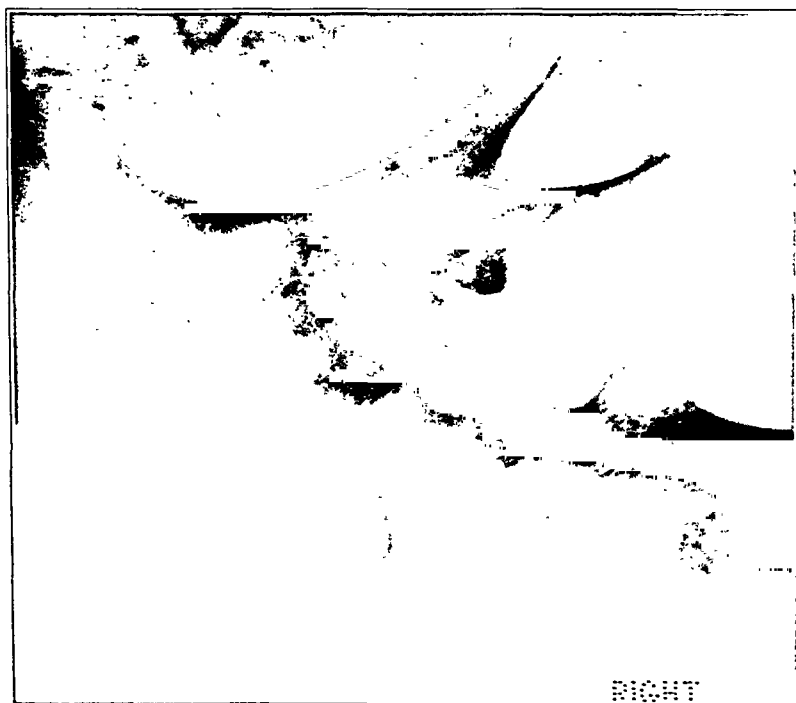


FIG. 5

One year after reduction.

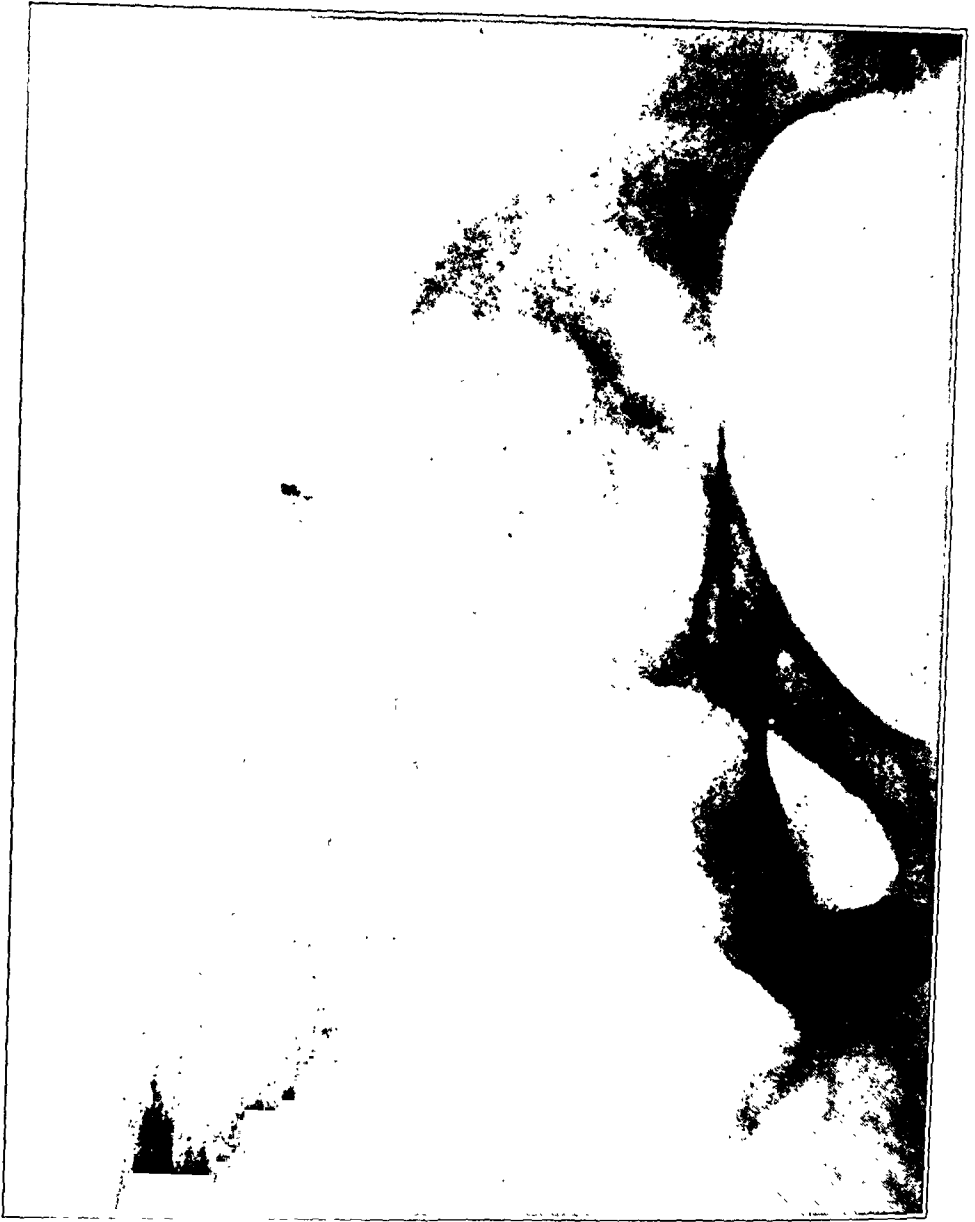


FIG. 7

Sixteen and one-half months after reduction, showing marked ossification of the capsule and transformation of the head, with no cartilage space.

The head appeared more round and smooth than in the previous film, and, while there was no demonstrable cartilage space, or shadow of articular cortex on the weight-bearing portion of the head, the outline of the head was fairly well defined. The new bone formation in the capsule at the upper portion of the joint was well marked. There was marked regional bone atrophy.

The patient was allowed to walk with crutches for six weeks, during which time the pain in the hip gradually decreased while the range of motion increased to thirty degrees of flexion. A roentgenogram (Fig. 7) taken at this time (May 9, 1931), showed apparent shortening of the neck, which is largely due to external rotation of the femur, and irregular increased density of that part of the femoral head in actual contact with the acetabulum. There was marked increased density of the acetabulum in the weight-bearing portion, while the lower portion showed rarefaction. The ossification of the capsule had increased so that it resembled a bone shelf thrown out from the acetabulum above the

TABLE I  
NECROPSY FINDINGS

Days	Ligamentum Teres	Contour of Head	Other Changes	Ligamentum Teres	Contour of Head	Other Changes
<i>Series 1-a. Division of Ligamentum Teres, Young Rabbits.</i>				<i>Series 1-b. Division of Ligamentum Teres, Circumcision of Neck, of Young Rabbits.</i>		
7	Ununited	No changes	No changes	Ununited	No changes	No changes
15	Reattached	No changes	No changes	Ununited	No changes	No changes
30	Ununited	No changes	No changes	Reattached	No changes	No changes
45	Reattached	No changes	No changes	Ununited	Smaller	Cartilage thin
60	Ununited	No changes	No changes	Ununited	Smaller	Cartilage thin, adhesions fill acetabulum
90	Ununited	Flattened	Cartilage thin. Neck shortened			Infected, head and neck destroyed
120	Reattached		Adhesions in acetabulum		Destroyed	Infected, part of neck remained
<i>Series 2-a. Division of Ligamentum Teres, Old Rabbits.</i>				<i>Series 2-b. Division of Ligamentum Teres, Circumcision of Neck, of Old Rabbits.</i>		
7	Ununited	No changes	No changes	Reattached	No changes	No changes
15	Ununited	No changes	None	Ununited	No changes	None
30	Ununited	Normal appearing	Neck absorbed so head can be moved on shaft although still attached	Ununited	Anaemic	Neck anaemic
45	Reattached	No changes	None	Reattached	No changes	None
60		Absorbed	Infected, neck absorbed	Ununited	Smaller, edges eroded	Cartilage thin, neck shortened
90	Ununited	Flattened	Cartilage thin, neck shortened		Destroyed	Infected. Stump of neck articulating with acetabulum
120	Ununited	Flattened	Articular cartilage thin, neck short	Reattached	Little smaller	None
<i>Series 3-a. Division of Ligamentum Teres, Old Dogs.</i>				<i>Series 3-b. Division of Ligamentum Teres, Circumcision of Neck, Old Dogs.</i>		
45	Reattached		Neck accidentally fractured after removal	Reattached	Little smaller	None
90	Ununited	No change	Cartilage a little thin	Ununited	Flattened	Hip dislocated, capsule adherent to superior portion of articular cartilage, cartilage thin and eroded, under surface of neck eroded and acetabulum partially filled with granulations
120	Reattached	No change	None	Ununited	Markedly flattened	Cartilage eroded, neck shortened, some granulation tissue in lower part of acetabulum



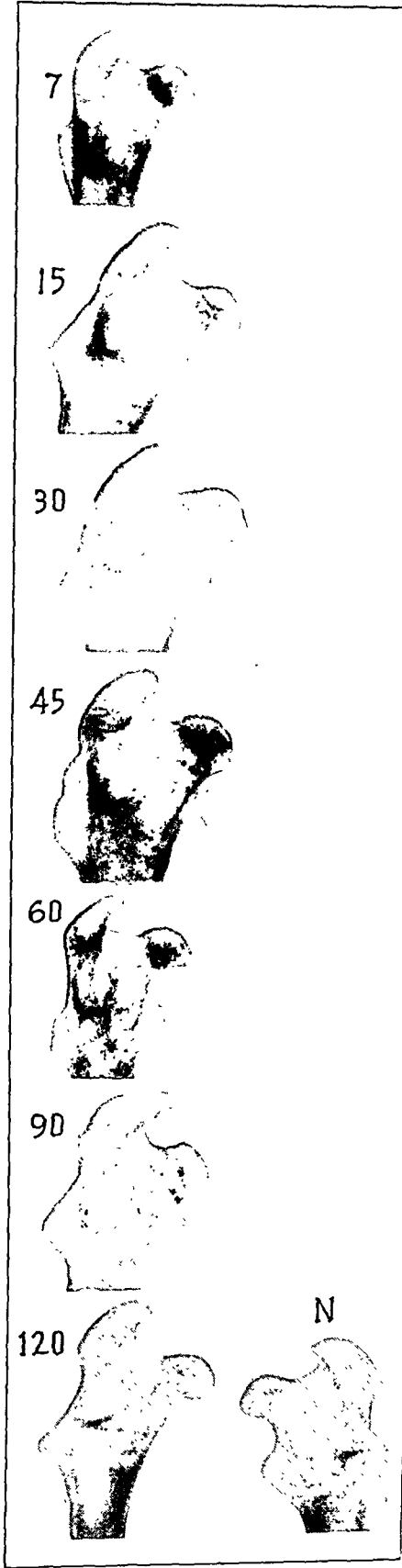


FIG. 8

Roentgenograms of Series 1-a.  
(Normal femora on right.)

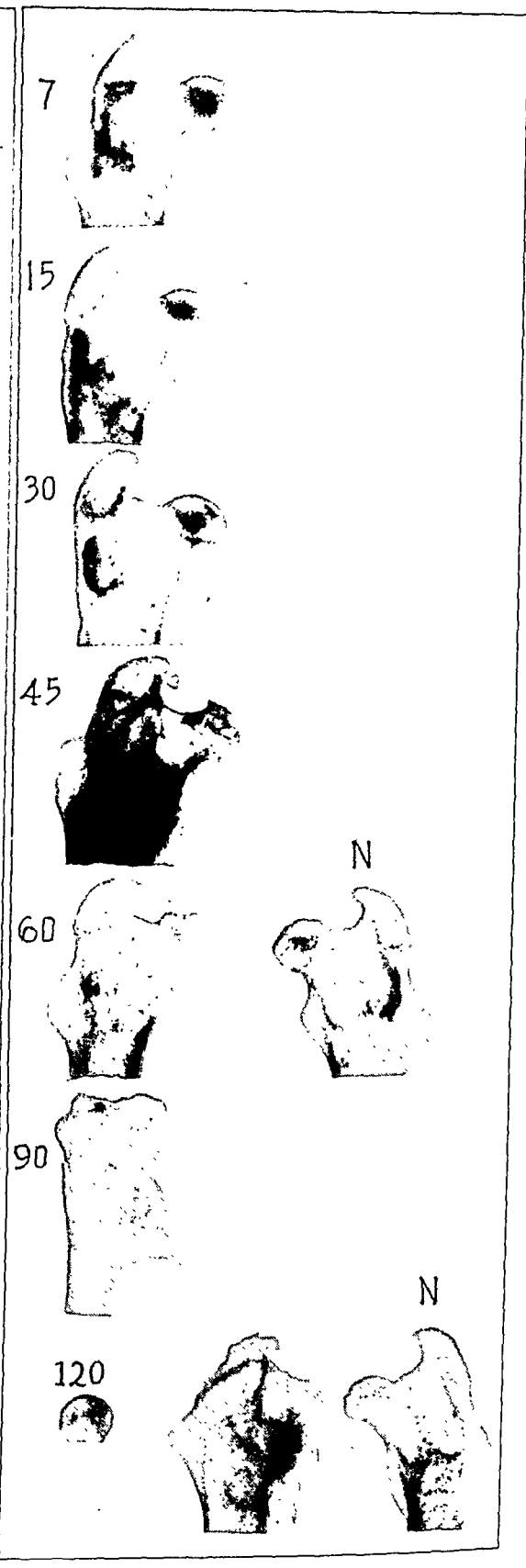


FIG. 9

Roentgenograms of Series 1-b. (Normal  
femora on right.)

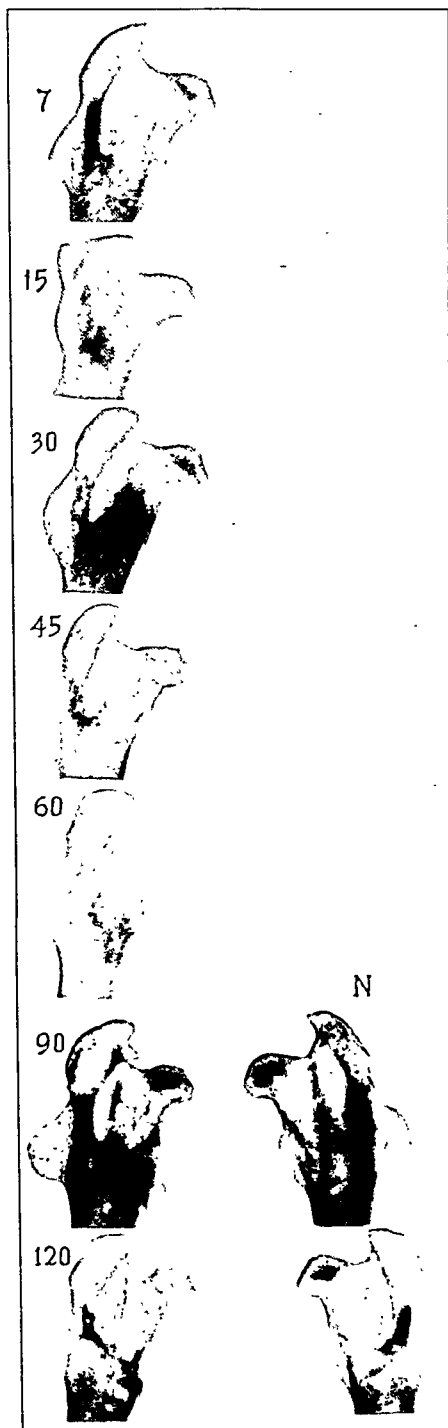


FIG. 10

Roentgenograms of Series 2-a. (Normal femora on right.)

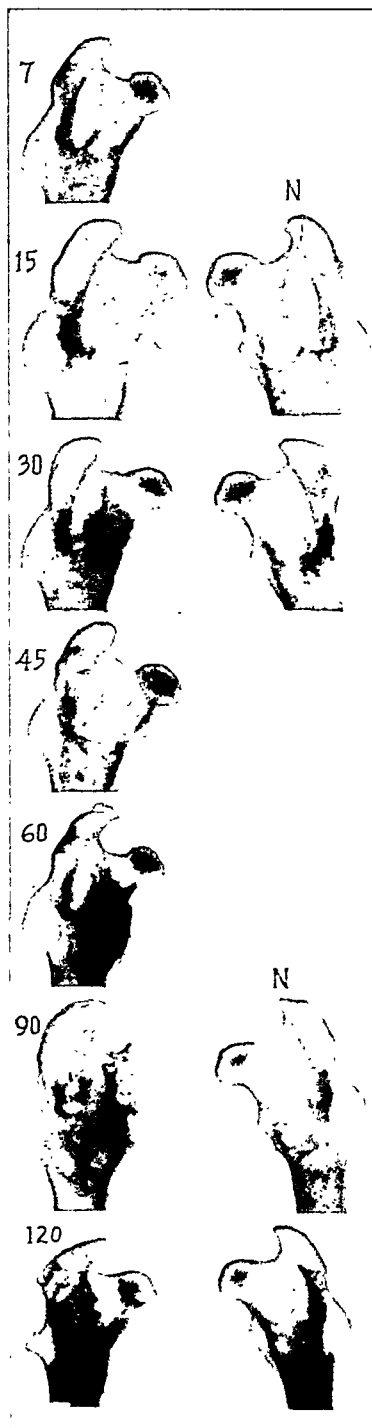


FIG. 11

Roentgenograms of Series 2-b. (Normal femora on right.)

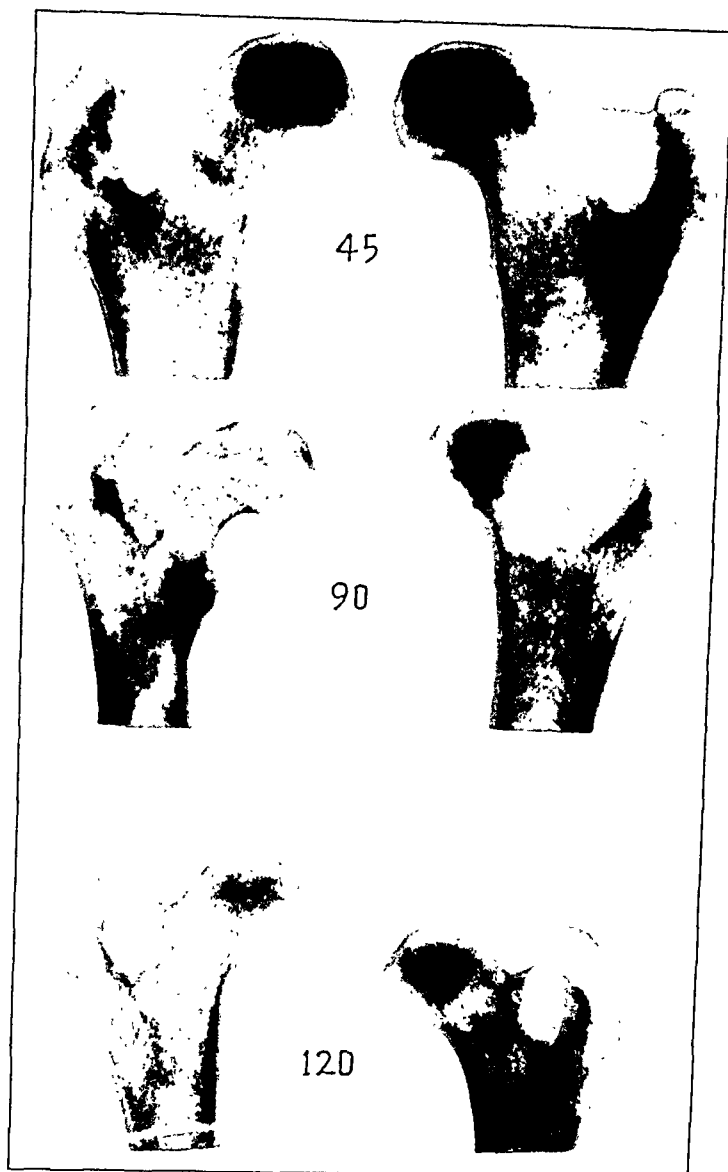


FIG. 12

Roentgenograms of Series 3-a. (Normal femora on right.)

head. The head was quite definitely rounded but hazy in outline, with no demonstrable joint space.

At the present time, May 13, 1932, increased weight-bearing is being permitted.

It was felt that the changes in the head of the femur were due to disturbances of its circulation following its forcible dislocation from its normal situation. Three possibilities of circulatory disturbance in this condition present themselves. First, rupture of the ligamentum teres; second, the capsule may have been torn from the neck; and lastly, a combination of these may have occurred. Because the dislocation was reduced immediately by closed manipulation, one can only speculate as to what actually happened to the blood supply.

According to Kolodny <sup>1</sup>, the blood supply of the head and neck of the femur in the new-born is from the ligamentum teres, periosteal, epiphyseal, and diaphyseal vessels; but in adult life, the ligamentum teres ceases to be a source of blood supply. However, Santos <sup>2</sup> has shown that vessels may be present in the ligamentum teres in adult life and be an active source of nutrition to the head. Chandler and Kreuscher <sup>3</sup> in a number of cases found blood vessels in the ligamentum teres, of a size indicating that they supplied an appreciable amount of blood to the head of the femur.

Graham <sup>4</sup>, and Zemansky and Lippmann <sup>5</sup> have attempted to produce osteochondritic changes in femoral heads. Axhausen <sup>6</sup> described complete necrosis of the proximal stump ten months after fracture of the neck of the femur in a sixteen-year-old boy, with the production of arthritis deformans of the hip joint. Phemister <sup>7</sup>, Müller <sup>8</sup>, and Willis <sup>9</sup> have had

femoral heads break down after reduction of slipped epiphyses. Phemister<sup>10</sup> has also reported aseptic necrosis of the head and neck of the femur following arthroplasty. Broca and Massart<sup>11</sup> reported arthritis of the hip joint in an adult, in which an osteitis of the head developed, followed by reossification and reformation of the head. Elmslie<sup>12</sup> saw typical osteochondritic changes develop in a child's hip following traumatic dislocation.

Marked arthritic changes have been reported in a hip of an adult, following traumatic dislocation, by Zadek<sup>13</sup>. This hip, however, was not reduced until nine weeks after the accident.

Ferguson and Howorth<sup>14</sup> concluded that arthritis in adults was the usual sequela of a previously slipped epiphysis. Badgley<sup>15</sup> reported marked arthritic changes only in untreated cases of slipped upper femoral epiphyses.

Sonnenschein<sup>16</sup> reporting traumatic dislocations of hips in adults, and Murphy<sup>17</sup>, Campbell<sup>18</sup>, Roello<sup>19</sup>, Maffei<sup>20</sup>, Doelle<sup>21</sup>, reporting cases occurring in childhood, make no mention of any marked late changes in the hips. Standard texts do not lay any great stress on the sequelae of traumatic dislocations.

Since it has been reported<sup>2</sup> that femoral heads may either die or remain alive following intracapsular fracture of the femoral neck, it might be surmised that in some cases of dislocation there might be enough interference with the blood supply of the head, from injury to the round ligament, to result in some degree of capital necrosis.

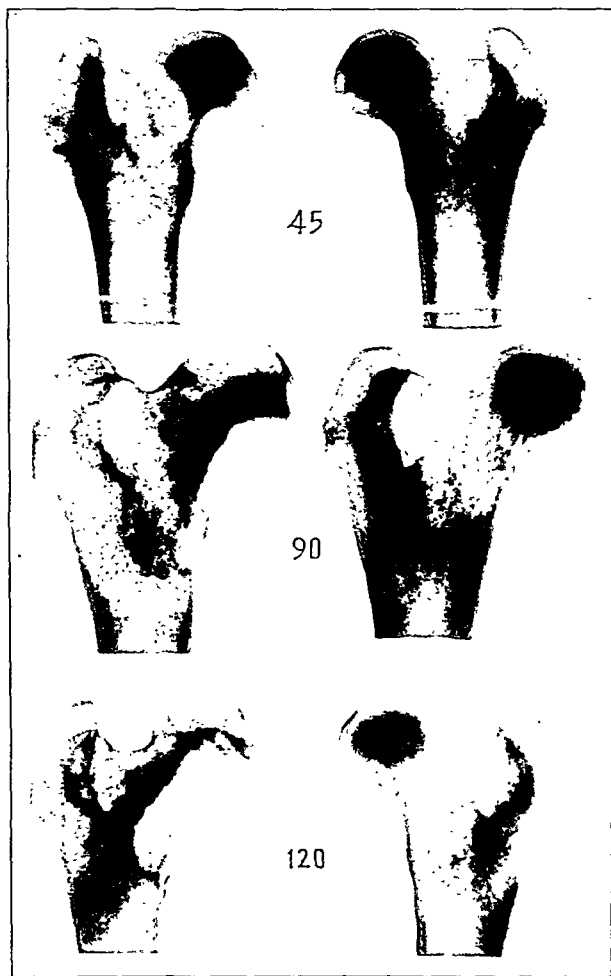


FIG. 13  
Roentgenograms of Series 3-b. (Normal femora on right.)

TABLE II  
ROENTGENOGRAPHIC FINDINGS

Days	Epiphyseal lines	Contour of head	Density	Other changes	Epiphyseal lines	Contour of head	Density	Other changes
<i>Series 1-a. (Fig. 8)</i>					<i>Series 1-b. (Fig. 9)</i>			
7	Head and trochanter open	No changes	Normal		Head and trochanter open	No changes	Normal	
15	Head and trochanter open		Normal		Head and trochanter open	No changes	Decreased in neck	
30	Head and trochanter open	No changes	Normal		Head nearly obliterated, trochanter open	No changes	Normal	
45	Head and trochanter open	Little flattened	Normal	None	Trochanter open, head closed	Undermining of head at superior and inferior portions at junction of head and neck	Several areas in head and neck decreased	
60	Trochanter open, head nearly closed	Somewhat flattened	Normal		Closed on operated side, open on normal	Flattened	Decreased head	Shortening of neck. Area of cavitation under fovea. Erosion of inferior portion of neck
90	Nearly closed	Irregular on superior portion	Increased in region of fovea	Cavity in inferior portion of neck		Complete destruction		Complete destruction of neck
120	Closed		Normal	Head displaced downward on neck at old epiphyseal line		Sequestered, irregular, central area decreased density		Complete separation of head and neck
<i>Series 2-a. (Fig. 10)</i>					<i>Series 2-b. (Fig. 11)</i>			
7	Closed	No changes	Normal		Closed	No changes		
15	Closed	No changes	Normal		Closed	Flattened and a little smaller		
30	Closed	No changes	Neck markedly decreased	Upward dislocation of neck on head at old epiphyseal line	Closed	No changes		
45	Closed	No changes	Some rarefaction, lower part of neck		Closed	No change		Erosion of under portion of neck

TABLE II (Continued)

Days	Epiphyseal lines	Contour of head	Density	Other changes	Epiphyseal lines	Contour of head	Density	Other changes
<i>Series 2-a. (Fig. 10) (Continued)</i>					<i>Series 2-b. (Fig. 11) (Continued)</i>			
60	Closed	Complete destruction (infected)		Complete absorption of head and neck	Closed	Little smaller and flattened	Neck decreased	Erosion of head and neck
90	Closed	Smaller	Some rarefaction of the neck	Erosion of under portion of the neck				Complete destruction of head, most of neck remaining
120	Closed	Smaller and flattened	Rarefaction of both head and neck	Erosion of under portion of neck	Closed	Smaller	Head decreased	Erosion of under portion of neck
<i>Series 3-a. (Fig. 12)</i>					<i>Series 3-b. (Fig. 13)</i>			
45	Closed	Somewhat smaller	Neck shows generalized rarefaction	Neck narrowed, slight destruction of under portion of neck. Fracture line through the neck, produced accidentally at necropsy	Closed	No changes	Normal	
90	Closed		Inferior portion of the head markedly decreased with spotty areas of reduced density in the weight-bearing portion above, loss of shadow of articular cortex in a part of its extent	Marked erosion of under part of neck	Closed	No changes	Superior portion of head decreased	Marked erosion of under part of neck at its junction with the head, and extending downward with some sclerosis of the adjacent bone
120	Closed	No changes			Closed	No changes	Neck and trochanter generally decreased	Destruction of almost the entire mesial and inferior half of the neck

TABLE III  
MICROSCOPIC EXAMINATIONS

<i>Series 1-a.</i>		<i>Series 1-b.</i>	
Days	Division of Ligamentum Teres in Young Rabbits.	Division of Ligamentum Teres and Circumcision of Neck in Young Rabbits.	
7	Small area of fibrous marrow in center of head, with some absorption of adjacent bone trabeculae. No other changes.	No changes in head or neck.	
15	No changes in head or neck.	Bone atrophy in the head, rather fatty marrow. No other changes.	
30	Cartilage is thinned below the fovea. Many bone-marrow giant cells.	Some bone atrophy of the trabeculae of the head.	
45	Slight flattening of the head. No other changes.	Small vessels in the stump of ligamentum teres. Undermining of each end of the cartilage by fibrous marrow which fills most of the cancellous spaces of the head. Some dead bone and cartilage at the superior portion. Large cavity in neck. Many of the trabeculae of head have new bone deposited on original old trabeculae, in which the bone cells are absent. Nearly complete transformation of the head (Fig. 14).	
60	Cartilage alive but irregular in thickness. Marked bone sclerosis below the fovea.	Loss of articular cartilage over superior weight-bearing portion, with fibrous-tissue invasion of the cortical bone. Marked fibrous-tissue invasion beneath the fovea. Cancellous spaces of the superior portion of the head contain active hemopoietic marrow. Rest of the cancellous spaces contain fibrous marrow. Below the fovea there are several trabeculae which show bone absorption on one side, with new bone production on the other side (Figs. 15, 16). The trabeculae in the inferior portion show dead bone surrounded by new bone. There are numerous small pieces of dead bone scattered through the fibrous marrow. Creeping substitution most marked in the central and inferior portion of the head. Nearly complete transformation of the head.	
90	Loss of articular cartilage over all the head except at each end. Marked bone sclerosis in the head. Most of the central cancellous spaces contain fibrous marrow, with fatty marrow in the remaining spaces of the head.	Complete destruction of the head and neck due to infection.	
120	No changes in the head or neck. Few small vessels in the stump of the ligamentum teres.	Inferior portion of the neck stub is covered with fibrocartilage. Bone of the sequestered head is dead, covered with dead calcified cartilage. Cancellous spaces contain cellular debris with many polymorphonuclear cells.	

<i>Series 2-a.</i>		<i>Series 2-b.</i>	
Days	Division of Ligamentum Teres in Old Rabbits.	Division of Ligamentum Teres and Circumcision of Neck in Old Rabbits.	
7	Small area of fibrous marrow in inferior portion of head, with adjacent bone absorption. No other changes.	Small area of fibrous marrow in center of neck, adjacent to head, with some bone absorption. No other changes.	
15	Fibrous marrow extends across entire neck in region of old epiphyseal line, with adjacent bone absorption. Marrow of rest of head is fatty.	Cartilage over superior portion is thinned. Fibrous marrow in center and inferior portion of head and all of neck, with some adjacent bone absorption.	

TABLE III (Continued)

<i>Series 2-a. (Continued)</i>		<i>Series 2-b. (Continued)</i>	
Days	Division of Ligamentum Teres in Old Rabbits.	Division of Ligamentum Teres and Circumcision of Neck in Old Rabbits.	
30	Cartilage irregular, with overlying adhesions, and dead. Bone trabeculae dead, marrow dead. Large cavity in neck, with a large area of granulation tissue back of this, containing live bone trabeculae and many polymorphonuclear cells. Infected.	Cartilage thin, irregular, head flattened. Marrow is fatty.	
45	No changes.	No changes.	
60	Infected. Head and neck destroyed.	Defect in cartilage over superior portion of head, with fibrous-tissue invasion. Head is smaller. Active hemopoietic marrow in cancellous spaces. Several areas of new bone production in the head. Many of the trabeculae have dead central portions surrounded by new living bone. All are very much thickened. Apparently head has been transformed.	
90	Sclerosis of bone trabeculae. No other changes.	Complete collapse of the head (Fig. 17). The central portion has a thick covering of cartilage with underlying bone growth. There is a section of dead cartilage below this, with another section of articular cartilage remaining at the inferior portion which is collapsed. Fibrous-marrow invasion throughout most of the head. New bone production surrounding old bone trabeculae. Nearly complete transformation of the remaining bone of head. Marked bone sclerosis in the neck.	
120	Cartilage worn away at each end. Area of fibrous marrow beneath the fovea, with adjacent bone absorption and new bone production.	Cartilage undermined and collapsed at each end, with some fibrous marrow in the lower portion of the head and neck.	

<i>Series 3-a.</i>		<i>Series 3-b.</i>	
Days	Division of Ligamentum Teres in Adult Dogs.	Division of Ligamentum Teres and Circumcision of the Neck in Adult Dogs.	
45	Cartilage is thin, covered with adhesions in region of the fovea. Cartilage is dead and undermined by fibrous marrow in inferior portion, with underlying dead bone trabeculae showing some absorption.	Good-sized area of fibrous marrow in the inferior portion of the neck, with adjacent bone absorption. Osteophyte formation at the superior portion of the neck, behind the cartilage, evidence of arthritis (Fig. 18).	
90	Cartilage is narrowed over most of weight-bearing portion of head. At the fovea, the cartilage is dead. Some bone atrophy in head. Evidence of lipping, osteophyte production behind the articular cartilage, on the neck.	Loss of cartilage over superior portion of head, replaced by thin fibrous tissue adherent to surrounding soft parts. Below the fovea, it is reduced in thickness; cells are necrotic and broken down. Still lower, it is undermined by fibrous marrow at margin, but is alive. The neck shows surface erosion inferiorly, with bone sclerosis above this region. Bone atrophy in the upper part of the head and neck (Fig. 19).	
120	No changes in head and neck.	Superior portion of cartilage is thinned. It is undermined at lower portion by fibrous marrow and collapsed. Bone atrophy of the superior portion of the head. More marked erosion of the under surface of the neck, with overlying bone sclerosis (Figs. 20 and 21).	





FIG. 14

Series 1-b, 45 days ( $\times 20$ ). Large defect in the central portion of head and neck. Sclerosis of remaining trabeculae; most of the trabeculae around the periphery have been transformed.

Accordingly, an attempt was made to interfere with the blood supply of the head of the femur in animals by division of the ligamentum teres or ligamentum teres and periosteum of the neck. Six series of ex-

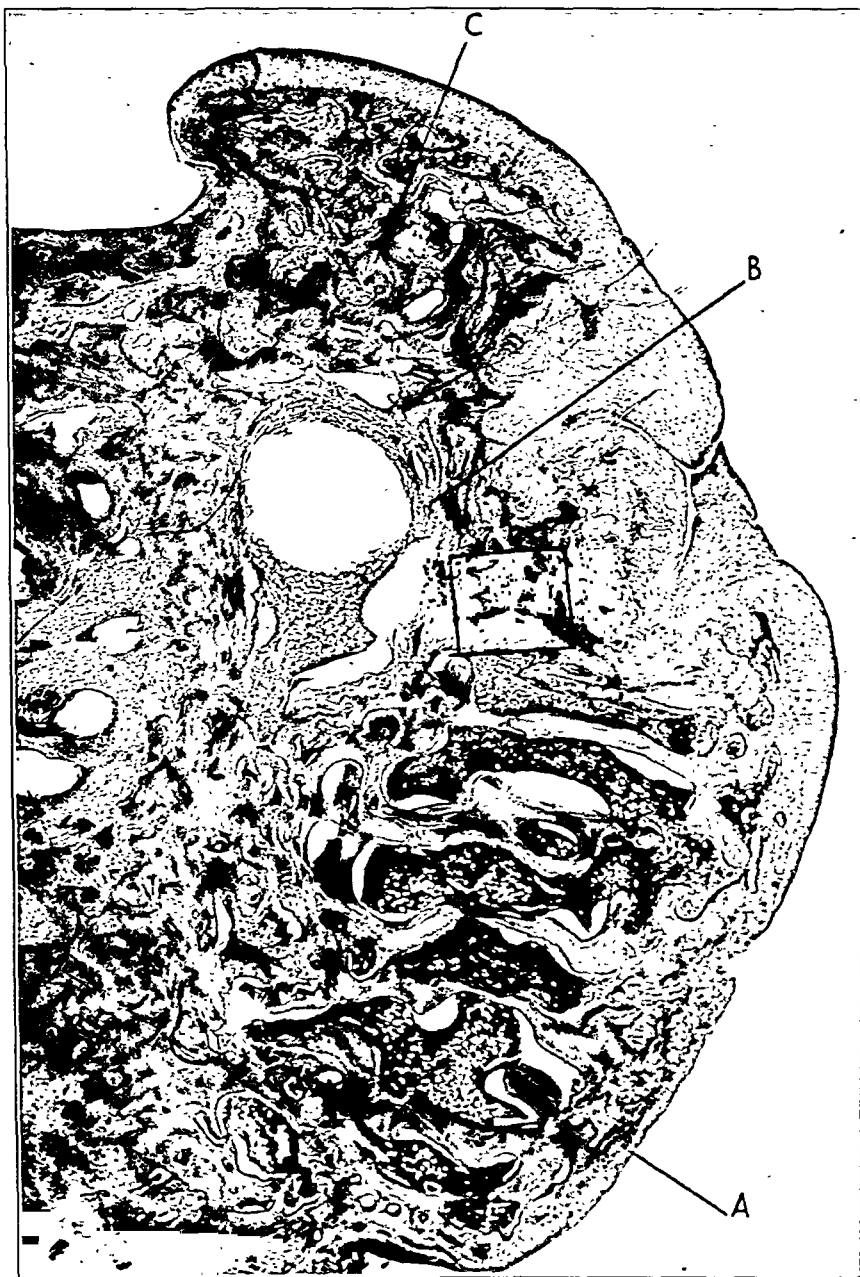


FIG. 15

Series 1-b, 60 days ( $\times 25$ ). Square reproduced in higher power in Fig. 16. A. Loss of cartilage over superior weight-bearing portion of head, with underlying cancellous spaces containing hemopoietic marrow. B. Active new bone growth. C. Old trabeculae surrounded by new bone and with adjacent cancellous spaces containing fibrous marrow.



FIG. 16

Photomicrograph ( $\times 260$ ) from Series 1-b, 60 days, taken from region below the fovea, showing: *A*, fibrous marrow; *B*, new bone growth, *C*, bone absorption, with a portion of an old, dead trabeculum surrounded by living bone.

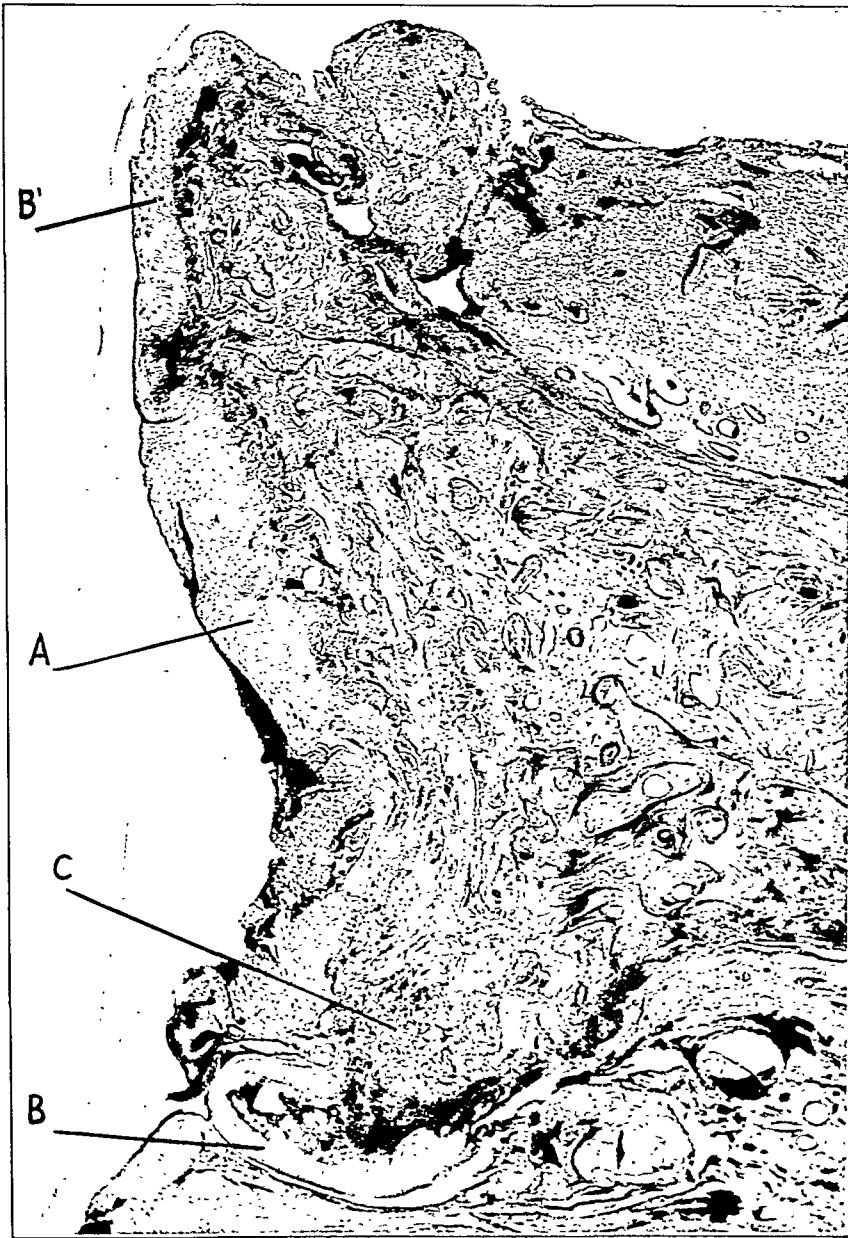


FIG. 17

Series 2-b, 90 days ( $\times 25$ ). Collapse of head. A. Fibrocartilage over central, collapsed portion. B, B'. Remnants of old articular cartilage. C. Fibrous marrow with adjacent active new bone growth. Generalized sclerosis of trabeculae.

periments were done. Rabbits about six weeks old, with open epiphyses, older rabbits with closed epiphyses and dogs with closed epiphyses, estimated to be three or four years old, were operated on and the results noted after varying intervals of time.



FIG. 18

Series 3-b, 45 days. Photomicrograph of head and neck ( $\times 10$ ), showing surface absorption of inferior portion of neck.

The following experiments were performed:

*Series 1-a.* The ligamentum teres in one hip of each young rabbit was divided. Seven animals were used and were killed at 7, 15, 30, 45, 60, 90, and 120 day intervals. The femora were then x-rayed and sectioned.



FIG. 19

Series 3-b, 90 days ( $\times 7$ ). Marked erosion of inferior portion of neck, sclerosis of trabeculae of neck and head, inferiorly, and atrophy of superior portion. Remnants of adherent capsule with loss of cartilage at the top.

*Series 1-b.* The ligamentum teres in one hip of each young rabbit was divided and the periosteum of the neck circumscribed by carrying a curved knife through it just below the head. The animals were killed at the same intervals as above, femora x-rayed and sectioned.



FIG. 20

Series 3-b, 120 days ( $\times 10$ ). Square reproduced in higher power in Fig. 21. Generalized atrophy of trabeculae of the head, with sclerosis of inferior portion of neck and surface absorption. No bone necrosis.

*Series 2-a.* Same procedure as in Series 1-a, using adult rabbits.

*Series 2-b.* Same procedure as in Series 1-b, using adult rabbits.

*Series 3-a.* The ligamentum teres was divided in one hip of each adult dog, and the animals killed at 45, 90, and 120 day intervals. The femora were then x-rayed and sectioned.



FIG. 21

Photomicrograph ( $\times 120$ ) showing sclerosis and surface absorption, with normal trabeculae and cancellous spaces. Section from inferior part of head and neck of Series 3-b, 120 days.

*Series S-b.* The ligamentum teres was divided in one hip of each adult dog, and the periosteum of the neck circumcised. Animals were killed at 45, 90, and 120 day intervals, femora x-rayed and sectioned.



The necropsy, roentgenographic, and microscopic findings are shown in Tables I, II, and III, with accompanying illustrations.

A résumé of the results of the experiments reveals four examples of aseptic necrosis of the head of the femur, followed by nearly complete transformation. All of these occurred after the more extensive method of devascularization,—namely, division of the ligamentum teres and circumcision of the periosteum of the neck. No marked changes occurred in the animals in which the ligamentum teres alone was cut.

No regular sequence of events in the progression of aseptic necrosis, followed by transformation of the head, was demonstrated. In several of the heads which were examined early in each series, small areas of fibrous marrow were found, but there are none that show the course of events between these and the heads which represent an advanced stage of transformation.

The absorptive changes which took place in the neck of the femur in each animal of Series 3-b are not well understood at this time. It is possible that there are end arteries in the neck of the femur, on the inferior aspect, which were injured at the time of operation, but additional work must be done before the changes can be interpreted. The heads of these femora present little evidence of aseptic necrosis, most of the changes being on a basis of arthritis and bone atrophy.

#### SUMMARY

1. The case reported is of interest because, despite the relative frequency of traumatic dislocation of the hip with accompanying tear of the round ligament, no report was found in the literature of a similar case of aseptic necrosis and breaking down of a part of the head of the femur as a sequel. The chronic arthritis of the hip appeared to be secondary to the necrosis. The picture is somewhat similar to that sometimes seen in intracapsular fracture of the neck of the femur, with necrosis of the head, in which bony union occurs but the head subsequently breaks down as a result of weight-bearing before bony transformation has taken place. When it becomes evident from roentgenograms that aseptic necrosis in the femoral head from any cause has occurred, weight-bearing should be avoided during the period of repair. A study of the late results of hip dislocation might reveal similar cases.

2. Attempts were made to reproduce the picture in dogs and rabbits by cutting the ligamentum teres and, in some cases, also the vessels in the periosteum of the femoral neck. They were only partially successful. A part of the bone died in some experiments, as shown in Table III, and was transformed; but in no instance was collapse of the head and necrosis of its articular cartilage observed. The divided ligamentum teres showed a distinct tendency to unite in the experimental animals. It appears that the vascular supply of the head of the femur by way of vessels within the femoral neck of these animals was usually sufficient to preserve the vitality of the head.

3. There was no regularity in the process of transformation of the femoral heads following operative circulatory interference. Apparently, the variability of the blood supply to the head of the femur is such that, by interrupting identical portions of it in a series of experimental animals, identical and progressive stages of aseptic necrosis, followed by transformation of the femoral heads, could not be demonstrated. There is a certain individual reaction of each head in a series of similar operative procedures.

4. The ligamentum teres showed a distinct tendency to unite after operative division.

5. No head in the animals with open epiphyseal lines showed changes similar to Legg-Calvé-Perthés' disease.

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## THE KRUKENBERG STUMP \*

BY RALPH COLP, M.D., F.A.C.S., AND NICHOLAS S. RANSOHOFF, M.D., NEW YORK, N. Y.

There are very few industrial injuries, or congenital deformities, more depressing to the surgeon, and more disabling to the patient, than the loss of a hand. The unfortunate individual faces a dismal economic future unless something can be done to convert a useless extremity into one which can assume some independent motion.

The application of an artificial hand to a healed forearm stump, while creating a better cosmetic appearance, does little to aid the one who wears the prosthesis, although the palmar slot arrangement in the artificial hand permits the insertion of pencils, knives, forks and other appliances. If the forearm, however, could be converted into a grasping extremity, sensitive to tactile sensations, heat and cold, a result would be obtained far superior to any insensitive immobile artificial hand.

Krukenberg, in 1917, described an ingenious operation to serve this purpose, but, unfortunately, the procedure seems to be but little known. The operation is simple. It consists of dividing the forearm, separating the radius from the ulna, giving each bone an individual muscular supply and skin covering. The end result is not unlike the claw of a lobster in appearance. The ulna remains immobile while the radius revolves and retains its ability to pronate and supinate. This operation is much simpler than the various kineplastic procedures which have been advocated, and, when completed, a complicated prosthesis is not necessary. It has the additional advantage over the other kineplastic procedures that it may be done at the time of the traumatic amputation in selected cases. If desired, a simple artificial hand may subsequently be fitted, which not only answers a cosmetic purpose, but also proves useful because of a mobility of the hand, transmitted through the mobile radial stump. A working prosthesis has also been manufactured which will enable the wearer to actually perform very heavy manual labor. These appliances hide the stump and answer in part the argument that the mobile claw is extremely unsightly. There is no doubt that this statement is true but after all a forearm which is strong, sensitive, and useful certainly outweighs the aesthetic side of this industrial problem.

Krukenberg recommended that the stump be at least twelve centimeters long, but others—notably Biesalski—have been willing to do the operation with a shorter stump (eight centimeters). The technique of the operation is simple, and it is easily performed under a tourniquet. An excellent detailed description of the procedure is given in Bier, Braun, and Kümmell.<sup>1</sup> A brief résumé is herewith appended:

\* From the Surgical Service of the Beekman Street Hospital, New York, N. Y., and the Orthopaedic Service of the Monmouth Memorial Hospital, Long Branch, New Jersey.

1. A U-shaped incision is made from the volar to the dorsal aspect of the forearm, slightly to the ulnar side, and over the attachment of the interosseus membrane to the ulna.

2. The dorsal incision is deepened to the extensor muscles. The extensor communis digitorum is identified, and the tendons to the second and third finger are sutured together. The tendons to the fourth and fifth fingers are similarly sutured. The extensor carpi ulnaris is left on the ulnar side. The brachioradialis and both extensor carpi radialis muscles are attached to the radius. The abductor pollicis longus, the extensor pollicis longus, and brevis are excised.

3. The volar incision is now deepened to the flexor muscles. The flexor carpi ulnaris and radialis are left on their respective sides. The divisions of flexor sublimis digitorum are treated similar to the extensor communis digitorum. The flexor profundus digitorum and the flexor longus pollicis are extirpated.

4. The median and ulnar nerves are identified and adequately resected and the stumps injected with alcohol.

5. The interosseus membrane is then slit *throughout* its length and removed, so that the radius and ulna are then separated for about twelve centimeters of their extent.

6. The flexor and extensor tendons are then sutured together over the radius and ulna respectively.

7. The radial stump as a rule may be covered with the overlying skin which is present.

8. It is very seldom, however, that there is sufficient integument to cover the ulna stump. It is usually advisable to do a pedicle skin graft to this stump from the side of the abdomen. This is best performed by making a skin flap and suturing it to the skin left on the ulna. The stump is immobilized to the abdominal wall for ten to twelve days. The skin flap is then freed from the abdomen and the closure completed.

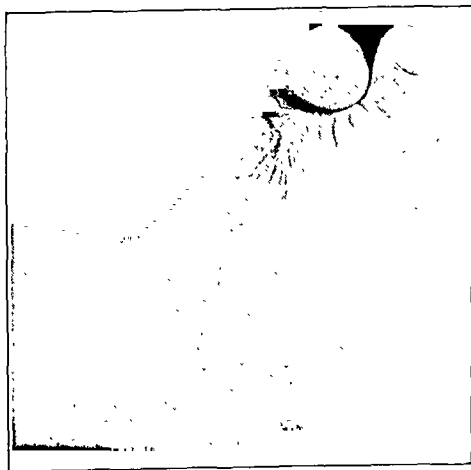


FIG. 1

Case 1. Claw closed.

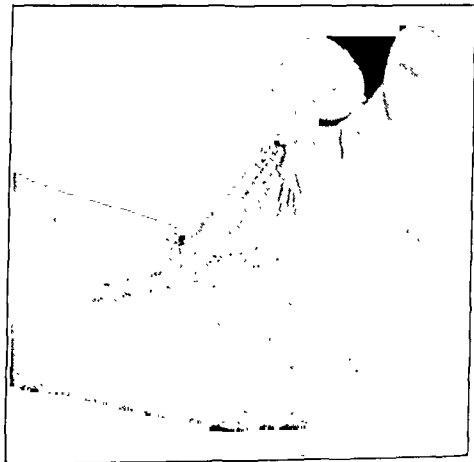


FIG. 2

Case 1. Claw opened.



FIG. 3

Case 1. Showing how girl holds her fork. She is able to feed herself easily with this. She has excellent control of the fork.

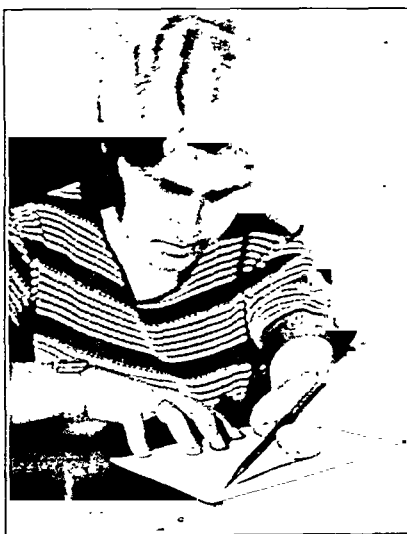


FIG. 4

Case 1. Showing her ability to grasp small objects, such as a pencil. She does not write with this, inasmuch as it is her left arm.

9. After the wounds have healed, active and passive exercises are begun, and pronation and supination are encouraged. After these motions are mastered, a pseudo-abduction and pseudo-adduction are apparent.

A very satisfactory mobile stump may be constructed by this method, and the histories of two patients which are herewith reported bear witness to the efficiency of the Krukenberg procedure.

CASE 1. J. B., aged fourteen, was admitted to the Monmouth Memorial Hospital at Long Branch, New Jersey, with a diagnosis of intra-uterine amputation of the left forearm.

The girl came to the clinic to inquire whether or not something might be done, or some prosthesis made, so that she might have some use of her left arm.

Her family history showed that she had a nephew with a congenital talipes equinovarus; otherwise the family history was negative.

She was admitted to the hospital December 17, 1929, at which time her physical examination was negative, except that it showed a stump of the left forearm, eight centimeters in length.

We realized that this would give a claw



FIG. 5

Case 2. Showing forearm before Krukenberg amputation.

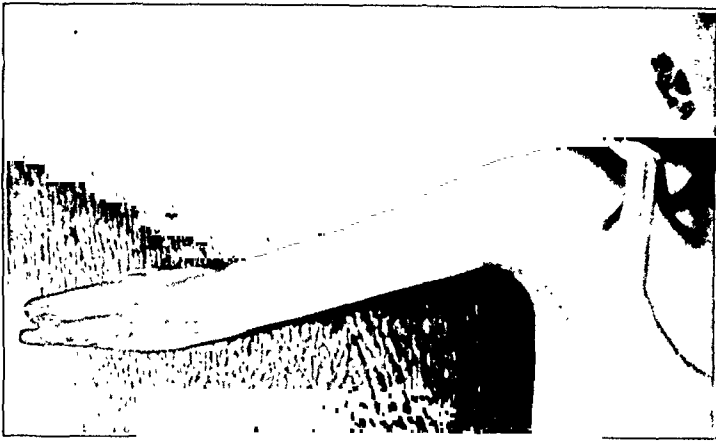


FIG. 6

Case 2. Showing Krukenberg claw in pronation.

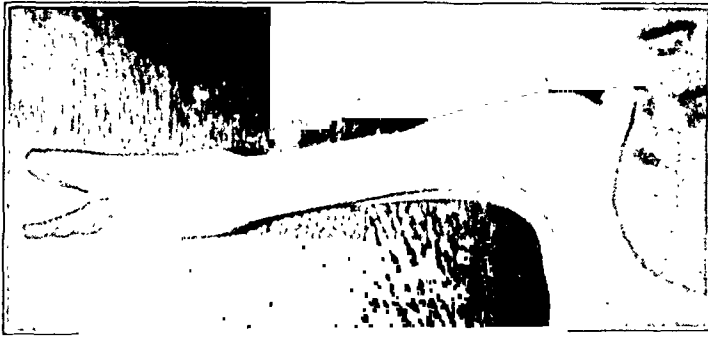


FIG. 7

Case 2. Showing Krukenberg claw in supination.

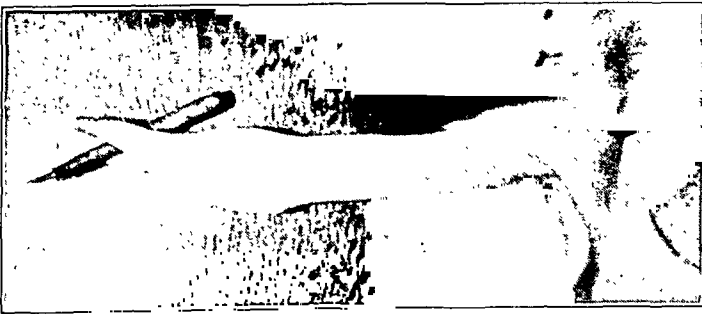


FIG. 8

Case 2. Showing grasping power of claw.

with very short fingers. Under gas-oxygen-ether anaesthesia, a typical Krukenberg operation was done December 22, 1929. The one variation from the technique was that both the radial and ulnar components of the stump were enclosed in the original skin by a primary suture. This was a mistake, as both the suture lines sloughed out. Therefore, under narcosis, a pedicle skin graft was done March 2, 1930. The pedicle was removed from its base March 19, 1930, with a primary union of the graft. A pinch graft of the pedicle bed was done at the same time.

At the present time, she has a short but useful Krukenberg stump; there are pronation and supination which give the effect of adduction and abduction. She is able to grasp small objects and hold them firmly; she uses her left forearm to hold a fork while eating; and, in general, is very happy with the result.

CASE 2. R. T., a school boy, twelve years of age, was admitted to the Surgical Service of the Beekman Street Hospital October 27, 1930, and discharged January 21, 1931.

On the day of admission, the patient held an ignited torpedo in his hand, which subsequently exploded. He was immediately brought to the hospital.

Physical examination disclosed a maceration and avulsion of the entire right hand up to and including the wrist joint, so that no bones were spared in the destruction. There were also powder wounds which extended through the skin into the soft parts, over the lateral aspect of the arm on the same side, to the mid-brachial region.

Under ether anaesthesia, an amputation of the right hand and wrist was performed through the carporadial articulation. The periosteum of the radius and ulna was not disturbed. The skin was trimmed for a considerable distance and the parts remaining looked very clean. The whole area was thoroughly irrigated with saline and a few

chromic sutures approximated the muscle and fascial elements over the ends of the bone, the skin being closed with a few submarine silk sutures. At the same time a débridement was also done on the powder wounds of the arm. Two pieces of iodoform gauze were inserted into the defects of the arm and the wound dressed dry.

There was considerable sloughing following the procedure, but under dakinization the stump was clean enough for a thiersch graft on November 21, 1930. This was subsequently supplemented by pinch grafts. The forearm was ready for a Krukenberg plastic operation on January 21, 1931.

On January 28, 1931, the wound was dressed. The skin flap around the stump of the radius had sloughed, while the pedicle flap to the ulna was viable.

On February 11, under general anaesthesia, the pedicle to the graft was divided and sutured about the ulna, although part of it remained uncovered.

On February 25, under anaesthesia, pinch grafts were taken from the right anterior femoral region and placed on the granulating area over the radius and parts of the ulna, and paresine dressing applied.

On March 4, 1931, the boy had amazing grasping power of the stump. The ulna was practically healed and about thirty per cent. of the pinch grafts of the radius had taken.

The patient was discharged on March 11, 1931, at which time the stumps had practically healed. There was complete extension at the elbow and the patient had good grasping power of the stumps. Since that time patient has been seen on many occasions. He has complete flexion and extension of the elbow; pronation and supination of the radius about the ulna is complete, although abduction and adduction of the radial stump are practically negligible.

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# ABSENCE OF THE CERVICAL SPINE \*

## KLIPPEL-FEIL SYNDROME

BY LEWIS GREENBERG, M.D., NEW YORK, N. Y.

In 1912, Klippel and Feil<sup>5</sup> first described in detail the clinical, roentgenological, and anatomical features of the relatively rare and obscure syndrome since known by their names. Their patient was an adult male, admitted to the hospital for an unrelated medical complaint which eventually resulted in death. The appearance of the patient, however, was so unusual and arresting that he was closely studied during life and minutely examined postmortem. Since the signs and symptoms exhibited by this patient were characteristic of all cases of the Klippel-Feil syndrome reported by other observers, they will be described here.

The most noticeable feature is an apparent absence of the neck; the head seems to rest directly on the trunk. This has led the French to designate these patients as "*hommes sans cou*," while the Germans refer to the condition as "*Kurzhals*". Another feature is the unusually low level of the posterior hair line (of the scalp); this actually reaches to the upper portion of the posterior thoracic wall. A third sign is considerable limitation of the movements of the head in all directions. With these very frequently there are present varying degrees of limitation of movements of the mouth (preventing satisfactory roentgenography of the upper cervical vertebrae), scoliosis or kyphoscoliosis of the upper dorsal region, elevation of the scapula as in Sprengel's deformity (often the first anomaly noticed by the patient or his family), and other congenital deformities or malformations. Some patients exhibit mental retardation of varying degree, although others are of normal intelligence. A few have shown functional impairment of the upper extremities, suggestive of a common neurogenous origin. Roentgenologically there is a bony block of all or most cervical vertebrae, with malformation and irregular segmentation of the remaining non-fused vertebrae,—the net result being considerable deformity of the cervical spine and numerical reduction of its component elements, a bone defect in the posterior portion of this cervical block (*spina bifida*), and a thorax extending upward practically to the base of the skull.

It is this roentgenographic appearance which has caused many writers to refer to the syndrome as "absence of the cervical spine". This term is quite obviously a misnomer for, while these patients show the most varied deformity and reduction in the number of cervical vertebrae, there is never a true total absence of the cervical spine.

As to etiology, the condition is manifestly a developmental anomaly, but the precise chronological and morphological point of departure

\* From the Orthopaedic Service, Hackensack Hospital, Hackensack, New Jersey.

from normal growth is still one of the mysteries of embryology.

Since the first description of the syndrome originated from France, it is but natural that the most detailed study of the condition and the greatest number of case reports emanate from French sources. Petresco-Poissonnier<sup>10</sup> has gathered all the known data about the syndrome into a thesis, in which she also reports two clinical cases. As summarized by this author, the outstanding features of the Klippel-Feil syndrome are: (1) important or constant clinical signs,—absence of neck (short, wide, "bull" neck), low hair line, and limitations of movements of the head; (2) secondary or occasional signs,—limitation of movements of the mouth, scoliosis or kyphoscoliosis, elevation of the scapula, lowering of the nipples toward the symphysis pubis; (3) roentgenographic signs,—bony fusion of all or most cervical vertebrae, posterosuperior triangular defect in this bony mass (cervical spina bifida), thorax reaching to base of skull (cervical thorax), and basal kyphosis,—*i.e.*, exaggerated downward direction of the posterior cranial fossa.



FIG. 1

Monestier<sup>7</sup> devotes himself to a consideration of the syndrome exclusively from the roentgenographic point of view, stressing the fact that an exact diagnosis must rest ultimately on the x-ray appearance of the cervical spine. In his experience the most constant findings were: bony block of all or almost all cervical vertebrae, cervical spina bifida, and cervical thorax. This author also quotes approvingly Feil's technical instructions for the successful roentgenographing of these subjects: forty-five centimeters' distance for localization of individual vertebrae or seventy centimeters for total roentgenography, one to four seconds' exposure, current of thirty to forty milliamperes, spark gap of seven to ten centimeters; no intensifying screens to be used; duration of exposure to be reduced for children. He calls attention to the occasional difficulty encountered in subjects with limitation of movements of the mouth when attempting to roentgenograph the upper cervical vertebrae.

Crouzon and Liège<sup>3</sup> describe the pathological findings in one of the rare cases of Klippel-Feil syndrome where postmortem study was possible. They found a reduction in the number of cervical vertebrae and great malformation and irregular fusion of the segments present, especially of the atlas and axis; the remainder of the spine was practically normal.

Ingelrans and Piquet<sup>4</sup> report two cases where, in addition to the anomalies and malformations of the cervical spine, there were present asymmetry of the face, deficient dentition, maldevelopment of the pinnae, and deformity of one forearm and hand. However, in one of these cases the authors thought they could find a syphilitic basis.



FIG. 2

Several other clinical cases are reported by French writers. Next in the number of case reports are those from Italy; isolated cases are on record from England, Holland, Germany, Russia, and the Scandinavian countries. From the United States there have been case reports by Meisenbach <sup>6</sup>, Noble and Frawley <sup>8, 9</sup>, and Bauman <sup>1</sup>. Sever <sup>11</sup>, in reporting a series of cases of anatomical defects of ribs and the spine as a whole, includes one case which would now be classified as Klippel-Feil syndrome. The total number of cases reported seems to be well below fifty.

The importance of recognizing the condition lies not in any hope of remedying the deformity—the therapeutic expectations are absolutely nil—but in its differentiation from two other conditions which present a somewhat similar appearance and which are amenable to surgical treatment,—namely, congenital torticollis and Pott's disease of the cervical spine. The affections have been confused, and there are instances where operation was undertaken under the erroneous impression that one of the

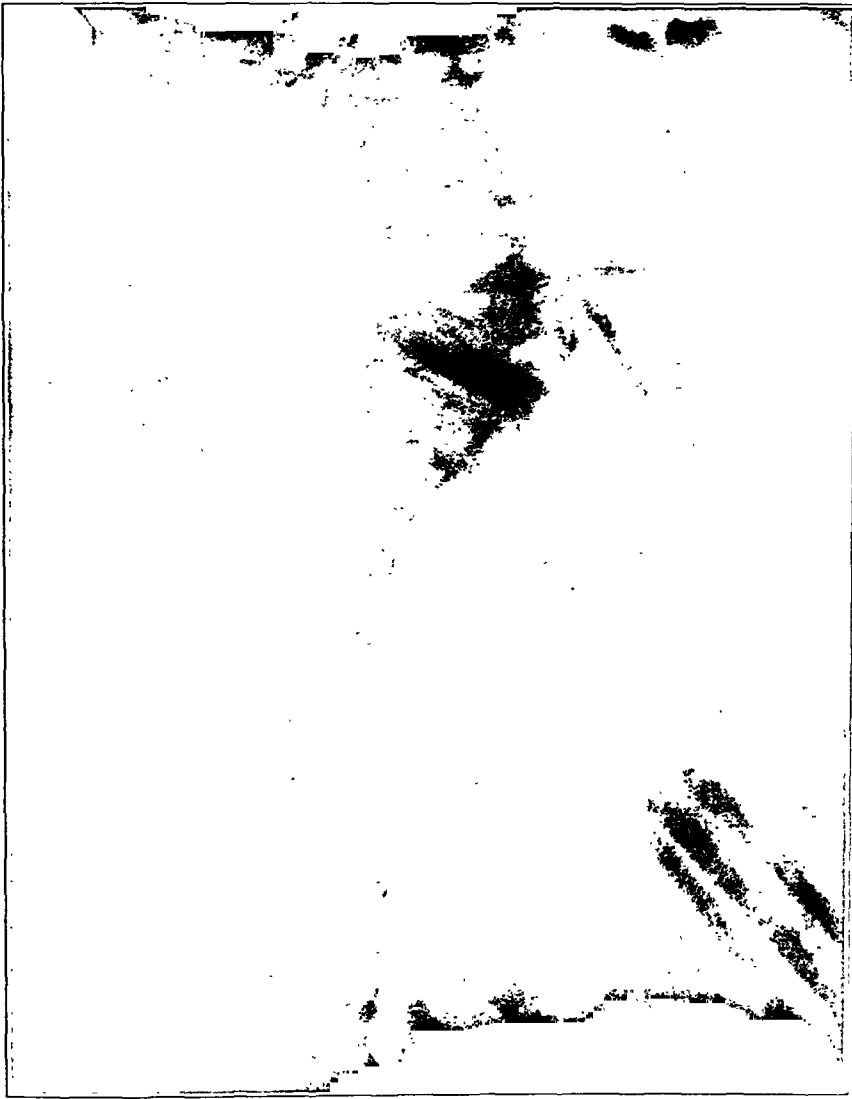


FIG. 3

latter conditions was being dealt with, with embarrassing and disappointing results. A frank, detailed report of such a misadventure is given by Böhm<sup>2</sup>. A boy, aged six and a half years, exhibited what looked clinically like the usual type of congenital torticollis (rotation of head to the right, inclination on the left shoulder, very short, thick, taut sternocleidomastoid). The patient was operated on, the usual myotomy being performed, followed by immobilization in the hypercorrected position. When the plaster was removed the deformity recurred at once. A further period of immobilization was followed by a similar result. Roentgenography revealed characteristic Klippel-Feil malformations.

It would also appear desirable to investigate the cervical spine in all patients presenting Sprengel's deformity, since this is relatively frequently one of the elements of the Klippel-Feil syndrome.

#### CASE REPORT

R. R., a five-year-old white girl (Fig. 1), was brought for examination because of a lump situated above the left shoulder which was said to interfere with movements of the head. This lump had existed since infancy and had increased in size proportionately as the child grew. It was not painful. The girl had been born *per vias naturales* without difficulty, and had developed normally, physically, and mentally, except for the "lump" and limitation of movements of the head due to it. Her parents appeared normal, and so did her younger brother and sisters. The "lump" was readily recognized as an elevated and rotated scapula and the diagnosis of Sprengel's deformity about to be entered. But there was something striking in the fact that, for a thin girl, the patient had an uncommonly short, thick neck. This, with the cervical and upper dorsal scoliosis and limitation of movements of the head in all directions, led to further investigation. Roentgenograms of the cervical spine (Figs. 2 and 3) revealed the true nature of the affection. There was no restriction of movements of the mouth, nor any other deformities or anomalies.

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# INTERMITTENT HYDRARTHROSIS OF THE KNEE JOINT

## A REPORT OF TWO CASES APPARENTLY CURED BY SYNOVECTOMY, TOGETHER WITH PATHOLOGICAL FINDINGS

BY ARTHUR KRIDA, M.D., F.A.C.S., NEW YORK, N. Y.

*Synonyms:* Hydrops articulorum intermittens; Hydrops intermittens; Hydrops genu intermittens; Hydrarthrose intermittens des genoux; Intermittierende Gelenkswassersucht; Typisch recidivierender Hydrops genu; Periodische Gelenkschwellung; Hydrops hypostrophos.

*Definition:* The term "intermittent hydrarthrosis" signifies a chronic condition in which repeated joint effusions occur, each of several days' duration, refractory to salicylates, unaccompanied by pronounced inflammatory manifestations, cardiac disease, or joint deterioration, and recurring in the main at regular intervals (Schlesinger <sup>1</sup>).

### HISTORY

Perrin <sup>2</sup> is credited with the first case report in 1845. Moore <sup>3, 4</sup> reported the next two cases, in 1864 and 1867. Benda <sup>5</sup> exhaustively reviewed fifty-five cases in 1900, and reported two cases, Linberger <sup>6</sup> reviewed the literature in 1901, and reported two cases. Schlesinger <sup>7</sup> in 1903 was able to collect sixty-five cases, and added two cases of his own. Bierring <sup>8</sup> in 1921, collected seventy-six cases and added one. Schlesinger <sup>1</sup> in 1926 stated that about 100 cases existed in the literature. This number would be materially reduced if his own criterion as to what constitutes the condition were applied in the evaluation of the reported cases.

### APOLOGIA FOR THE REPORT OF TWO CASES

The report of additional cases of this curious condition, except to augment statistical material, would hardly be of interest, unless a distinct contribution to the subject be demonstrated.

The writer here reports two cases, in which for the first time excision of the synovial membrane (synovectomy, Swett <sup>9</sup>) was performed, and in which for the first time a suitable opportunity for the study of the pathological changes in the synovial membrane was afforded.

### GENERAL CHARACTERISTICS AND SYMPTOMATOLOGY

The knee joint, more often singly, but frequently bilaterally, is practically invariably involved, rarely in association with other joints. The condition is characterized by a periodically recurring effusion into the affected joint or joints of several days' duration, followed by an interval during which the joint rapidly assumes its functional integrity and becomes symptom-free.

The intervals of freedom vary from seven to twenty-one days, rarely exceeding those limits. The typical interval is eleven or twelve days. The periodicity is not invariable in the individual case, except that a definite periodicity is encountered in relatively long periods of time, during which, if more than one joint be affected, each joint is apt to maintain its own periodicity. Time and circumstance may alter the extent of the effusion and also the intervals between attacks.

The stage of effusion is usually moderately uncomfortable to the patient, and the disability and such restriction of movement as may be present are occasioned by the distention of the joint. When both knee joints are affected simultaneously, the disability is of course more pronounced. In some individuals, the stage of effusion is accompanied by a good deal of pain, and constitutes a major disability.

The effusion is not accompanied by the signs which one associates with an active inflammation of a joint. There is little or no increased heat, no infiltration nor muscle spasm, no tenderness, and no constitutional reaction. The distention of the joint is evident upon palpation.

With regard to duration, it may be stated that the condition persists for years, and is liable to recurrences after intervals of freedom. Blanc <sup>10</sup> recites a history of twenty-two years' duration.

The clinical picture is striking; there can be no confusion with other joint-disease entities. Treatment has, on the whole, been exceedingly unsatisfactory.

#### ETIOLOGY

While the general symptomatology of the condition may be easily described and is generally understood, the etiological factors concerned in its development are not so clear. The complicated factors which are involved in the etiology of intermittent hydrarthrosis remain to be evaluated. Such an evaluation of etiological factors is attempted in the summary which follows.

1. *Age.* Intermittent hydrarthrosis occurs predominantly in the third and fourth decades. Of fifty-seven cases, one had its onset at seven; seven between ten and fifteen; nine between fifteen and twenty; eighteen between twenty and thirty; thirteen between thirty and forty; four between forty and fifty; two between fifty and sixty years of age. In three cases the age was not stated (Benda <sup>5</sup>).

2. *Sex.* The incidence in the sexes is practically equal. In Schlesinger's <sup>7</sup> series there were thirty-two males and thirty-five females.

3. *Race.* All reported cases have occurred in whites.

4. *Heredity.* With the exception of Blanc's <sup>10</sup> report of intermittent hydrarthrosis occurring in mother and daughter, there is little to indicate a background of heredity. In both mother and daughter the left knee was involved, and the periodicity of the attacks was the same. Schlesinger <sup>1</sup> reports the case of a woman with intermittent hydrarthrosis, one of whose two brothers, both sisters, and one cousin were similarly affected, the periodicity in each case being the same.

5. *Trauma.* That trauma plays an important rôle in a considerable percentage of cases is evident from a perusal of the reported cases. In Moore's<sup>3</sup> first case, the condition developed after unaccustomed scrubbing of stone steps; a loose body in the knee joint was present. A loose body was present also in his second case. Grandidier<sup>11</sup> reports a typical case in a woman of fifty-four which followed a severe fall on the knee. There are numerous other reported instances in which a definite trauma antedated the development of the condition; in this group must be included the writer's first case. Over one third of the cases had a reasonably laborious occupation.

6. *Infection.* The only case on record in which a direct connection between intermittent hydrarthrosis and a general infection has been established by bacteriological methods is Baker's<sup>12</sup> remarkable case of undulant fever. In this there was a typical intermittent hydrarthrosis syndrome affecting both knees, and of seven months' duration. An organism of the *Brucella melitensis* group was recovered from the blood stream, from the urine, and from the joint effusion. The use of a vaccine made from the organism resulted in a cure of the undulant fever, but only temporary amelioration of the hydrarthrosis.

In Pulawski's<sup>13</sup> case, an attack of typhoid fever had the apparent effect of establishing a definite periodicity in what was, prior to that infection, an irregularly recurrent hydrarthrosis. He reports finding an encapsulated coccus similar to the pneumococcus in smears of the joint effusion, but did not succeed in growing it on media.

7. *Arthritis.* The association of intermittent hydrarthrosis with "rheumatism" and rheumatoid arthritis has been frequently noted. These cases should be divided into two groups: (1) those in which there is a previous history of "rheumatism" or of inflammatory joint affections of undetermined character, with recovery without joint deterioration, and (2) those in which there was associated a concomitant rheumatoid arthritis.

In the first of these groups, a few case reports relate antecedent "rheumatism". Thus in Billroth's<sup>14</sup> and in Weisz's<sup>15</sup> single cases, a gonorrhoeal infection antedated the attacks. In Bierring's<sup>5</sup> case there was a well defined history of rheumatic fever.

In the rheumatoid arthritis group, periodic effusions have occasionally been noted. Garrod<sup>16</sup> reported eight cases of intermittent hydrarthrosis, five of which he classed as of the symptomatic type, in the course of, and with the persistence of, the rheumatoid disease. Hartmann<sup>17</sup> reported a very atypical case occurring in the course of wide-spread joint involvement with rheumatoid disease. Breslauer's<sup>18</sup> case is slightly better in this regard.

It must be stated here that the cases in the above mentioned group, while they may exhibit a certain periodicity of joint effusion, may be challenged for inclusion in the general group of intermittent hydrarthroses.

8. *Menstruation and Pregnancy.*





FIG. 1

Gross appearance of the tissue from Case 1.

later, and recurred eleven days after abortion at seven months. In Blanc's <sup>10</sup> report of two cases, the mother, after childbirth, exhibited an intermittent hydrarthrosis which lasted twenty-two years. Paus <sup>22</sup> reports a case of nine years' duration, which developed six months after the first labor. Fridenberg <sup>23</sup> reports a case of seven years' duration which intermitted entirely during two pregnancies.

9. *Neuropathic Predisposition.* Féré <sup>24</sup> has reported five very atypical cases in which psychic factors would seem to have played a rôle. Bum <sup>25</sup> reports the case of a young neurasthenic male in whom an intermittent hydrarthrosis of the right knee joint developed.

10. *Sensitization, association with vasomotor disorders (Quincke).*

*Menstruation.* In only a single case has an approximate parallel been drawn between the menstrual cycle and intermittent hydrarthrosis. Senator <sup>19</sup> reports a case in which attacks of somewhat variable periodicity, but commonly associated with menstruation, began one year after the onset of that function. However, in the second case reported in the present paper, a very definite association of the cycles of hydrarthrosis and menstruation was encountered.

*The Influence of Pregnancy.* Canonne <sup>20</sup> reports the first case in which pregnancy was a direct factor. Six weeks postpartum there occurred an inflammation of the ankle joint; during its recrudescence the right knee became the seat of an effusion which recurred at fourteen-day intervals. Panas <sup>21</sup> reports the onset of the condition in a young woman six months postpartum. The condition persisted until she again became pregnant four years

In 1924 <sup>26</sup> Miller and Lewin reported the case of a man who had had the condition for sixteen years, and was apparently cured by desensitization with intravenous typhoid vaccine injections, continued over a period of some months. Urticaria developed after each injection. The association with asthma has occasionally been noted, as in Burchard's <sup>27</sup> case, in which the asthma alternated with the intermittent hydrarthrosis. Schlesinger and also Garrod would like to ally the condition with angio-

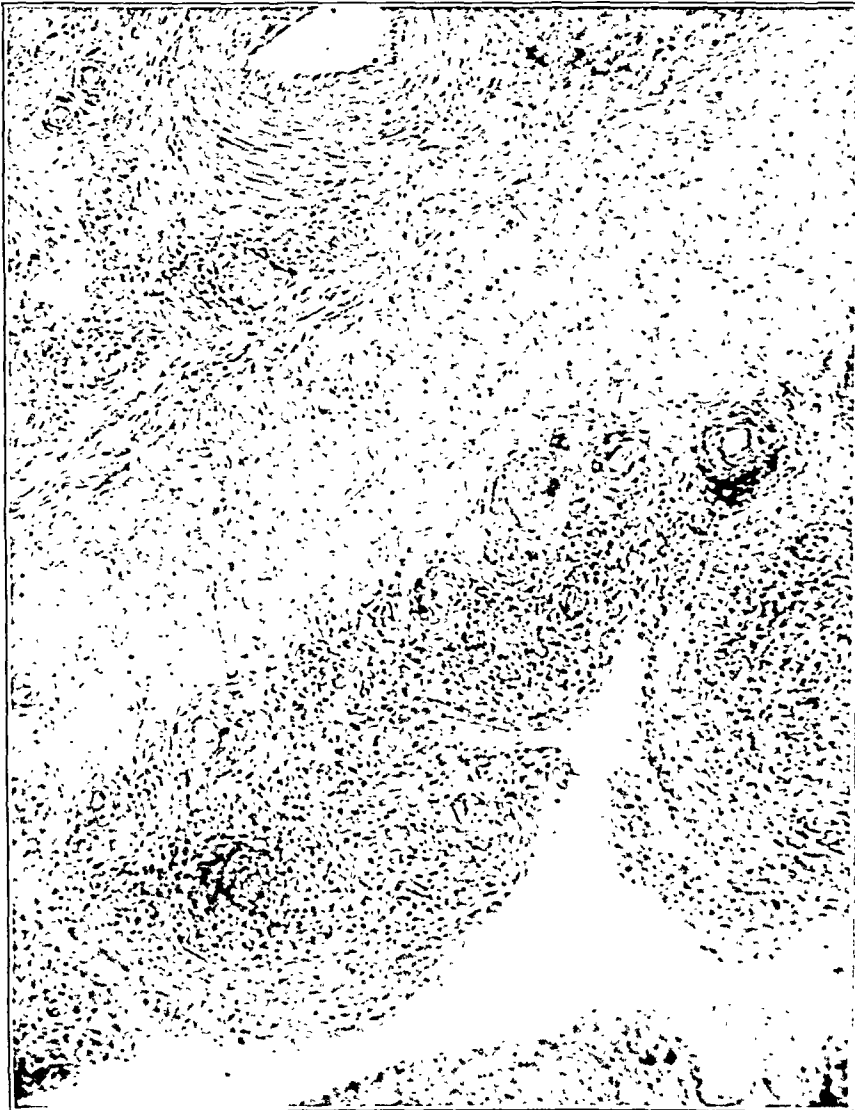


FIG. 2

Section shows flattened villi with marked round-cell infiltration. Low power from Case 1. The operation in this case was done during the height of the attack.

neurotic oedema, although the number of such reported cases is quite small, and the association not well defined.

11. *Unknown Etiology.* This group contains the larger number of cases in which no precise etiology could be established.

#### PROGNOSIS

All observers agree that the prognosis in the average case is not good, but that sometimes, with or without treatment, or despite treatment, the attacks will cease. Sometimes the attacks may cease in the affected joint, and the periodicity be transferred to another joint. Occasionally, a recurrence of the cycle may take place after a long interval of freedom.

#### TREATMENT

Treatment on the whole has not been satisfactory. Quinin and arsenic have been extensively used, seldom with success. Rest and splintage are of no avail, which is true also of the various physiotherapeutic measures. Aspiration has been frequently applied, without affecting the course of the condition. Aspiration and lavage followed by iodoglycerin injections are reported to have been successful in two cases. Iodin and carbolic acid solutions are reported to have resulted in improvement in two cases. Arthrotomy, with evacuation of the exudate, is reported as having been curative in one case. On the other hand, Nielson<sup>28</sup> reports a case in which two arthrotomies were done without relief.

CASE 1. Male, aged twenty-six, Lithuanian parentage, married. Referred by Dr. E. M. Nash, Chief Surgeon, New York State Insurance Fund, on December 23, 1930.

Seven months previously he had been struck in the upper portion of the left calf by a falling plank. He was in bed at home for three weeks. At the end of that time he appeared to be quite well and he returned to his work as a plumber. Two weeks later, on a Monday, he experienced a drawing sensation at the back of the left knee. On Tuesday, the knee was swollen. On Wednesday, the swelling subsided.

On alternate Mondays since that time, this cycle of events has recurred. The attacks invariably began with a drawing sensation in the calf and a sense of tightness in the knee joint. On Tuesday morning the joint was distended and uncomfortable. On Wednesday the swelling and discomfort gradually abated, and on Thursday the joint appeared to be quite fit for the demands which his occupation made upon it.

Upon examination, which happened to coincide with the episode of effusion, the joint was found to be moderately distended with fluid, which limited the range of motion moderately. There was no increased heat, and no tenderness. An indefinite thickening could be felt in the upper third of the calf, evidently imbedded in the substance of the muscle.

The patient was admitted to the Hospital for the Ruptured and Crippled on a Wednesday, five weeks later. The joint was aspirated; the Wassermann reaction of the blood and of the joint fluid was negative. The joint fluid was clear, and not abnormal in cellular constituents. The chemical examination of the blood showed that the blood sugar, uric acid, and urea nitrogen were within normal limits. The blood count was normal; the blood pressure 135/70.

The patient was purposely kept in bed in order that the next cycle might be observed under conditions of complete rest. On the second Monday afternoon he began to have some discomfort in the calf and a sense of tightness in the knee. On Tuesday morning the joint was, as usual, distended with fluid. Fifty cubic centimeters of clear

fluid was aspirated, and of this amount eight cubic centimeters was reinjected subcutaneously (autoserotherapy). There was no effect upon the course of the cycle.

An exhaustive sensitization study was then made by Dr. Will Cook Spain. Intracutaneous tests of 137 substances and organisms failed to show any reaction. The substances tested for are detailed below:

Milk	Lima bean	Salmon
	White potato	Crab
Egg	Squash	Lobster
	Spinach	Shrimp
Wheat	Green pea	Bluefish
Barley	Cauliflower	Haddock
Rice	Turnip	Clam
Oats	Onion	Flounder
Rye	Beet	Scallop
Cornmeal	Carrot	Mackerel
Buckwheat	Tomato	Herring
	Mushroom	Halibut
Veal		Oyster
Chicken	Pineapple	
Beef	Grape	Timothy
Turkey	Orange	Ragweed
Pork	Raisin	Orris
Lamb	Grapefruit	Dust
Goose	Apple	Dog epidermis
	Fig	Cat epidermis
Coffee	Cantaloup	Goose epidermis
Tea	Rhubarb	Chicken epidermis
Chocolate	Pear	Duck epidermis
	Lemon	Rabbit epidermis
Black pepper	Banana	Horse epidermis
Nutmeg	Prune	Horse serum
Allspice	Strawberry	Tobacco
Clove	Blackberry	Le Page
Mustard	Apricot	Sheep's wool
Cinnamon	Plum	Silk
Honey	Raspberry	Black flag
Vanilla	Cherry	Cottonseed
	Peach	Staphylococcus aureus
Lettuce		
Cucumber	Pecan	Staphylococcus albus
Radish	Almond	
Celery	Peanut	Pneumococcus IV
Navy bean	Chestnut	Pneumococcus II
String bean	English walnut	Micrococcus catarrhalis
Corn	Cocoanut	Bacillus influenza
Asparagus		Streptococcus hemolyticus
Sweet potato	Smelt	Streptococcus non-hemolyticus
Cabbage	Codfish	

At the height of the subsequent attack on Tuesday, February 17, 1931, operation was done. The joint was opened by what has been described by the writer<sup>22</sup> as the "general utility incision for exploration of the knee joint," under tourniquet. This incision extended from the top of the quadriceps pouch in the mid-line downward, sweeping around the inner margin of the patella, then alongside the patellar tendon, to the tibial tubercle.

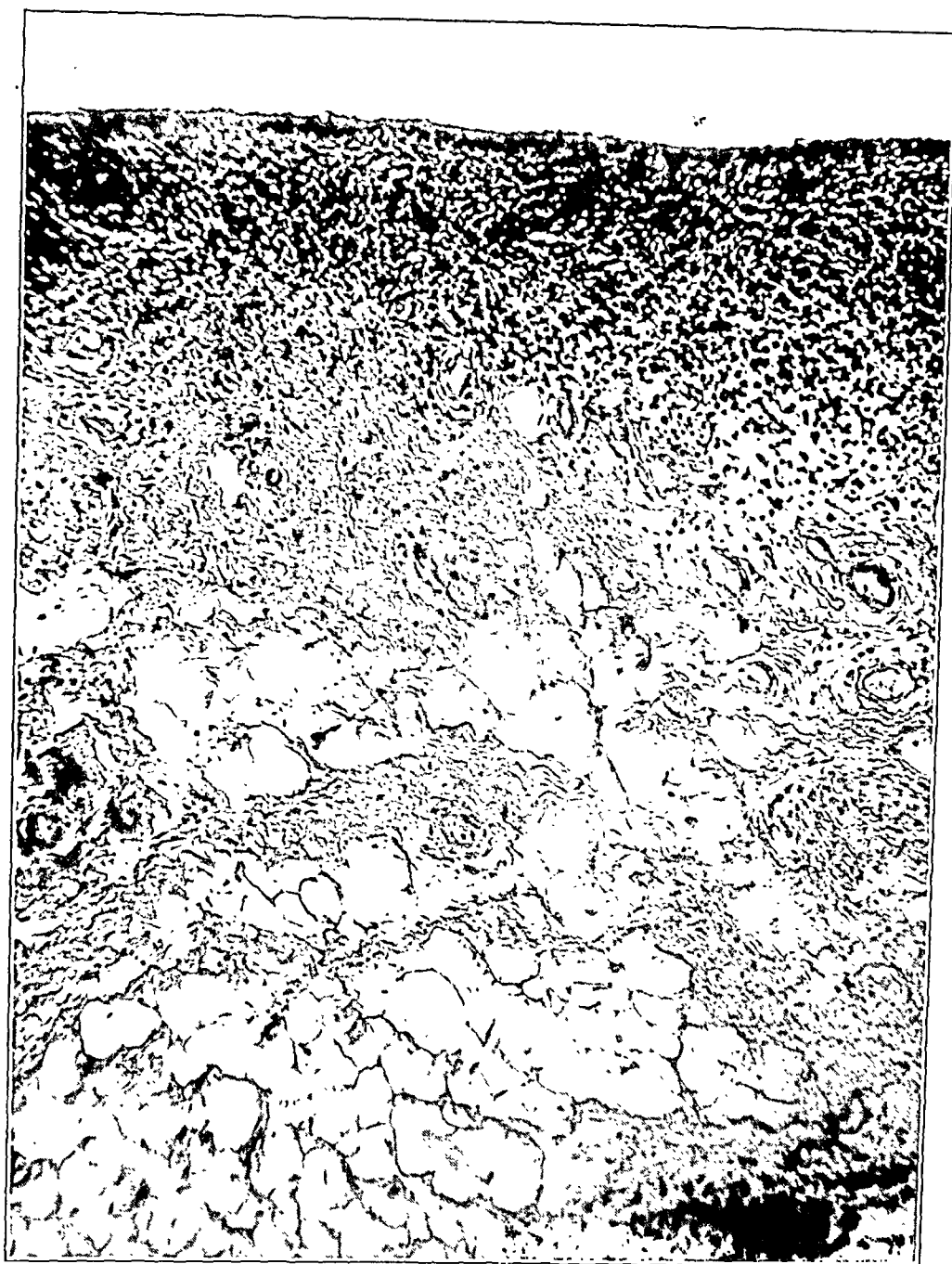


FIG. 3

Shows intense round-cell infiltration of the synovial membrane.

#### *Operative Findings*

Upon opening the joint, a considerable quantity of thin rather deep yellow fluid was evacuated. The synovial membrane was thickened about one-quarter of an inch, and presented several tab-like projections. It was pale pink in color. The infrapatellar fat pad was enlarged, and the synovial membrane covering it had a similar pale pink appearance. The articular cartilage of the patella presented a rather diffuse superficial fibrillary degeneration, evidently of traumatic origin.

The synovial membrane was thoroughly excised; the fat pad was excised. Bleeding points were much more numerous than usual, and such were ligated. The joint was closed in layers.



FIG. 4

High-power photomicrograph of an area in Fig. 3, demonstrating the round-cell infiltration and the marked oedema. ( $\times 440$ .)

A second incision was made over the upper portion of the calf. Beneath the deep fascia, and imbedded in the muscle, was an ill defined mass about two by three-quarters inches, of tough fibrous consistency, and presenting several brownish stains, evidently of hematogenous origin. This was excised.

There was rather more postoperative reaction than is usual. The man was allowed to walk on the sixteenth day, then having had no evidence of any degree of recurrence of the previous cycle of effusion. The range of motion gradually returned. At the end of three months he returned to his work, having at that time a range of motion to well beyond a right angle.

One year after operation, there had been no further disability nor any recurrence of effusion.

The second case is from my service at Bellevue Hospital, and was operated upon by my associate, Dr. Paul C. Colonna.



FIG. 5

Section through the fibrous mass from the calf muscle.

CASE 2. Female, aged nineteen, single. Six years before, patient had an illness with fever and prostration which confined her to bed for two weeks. One month after her recovery the right knee swelled up and remained swollen for four or five days. In the course of one year she had frequent recurrences of the swelling for four or five days, but with no regularity. At the end of one year the left knee began to swell up in a similar manner. For six months this series of events continued in both knees. The right knee apparently got well, but the swelling remained in the left until her menstrual periods began at the age of sixteen, when, one month after the first period, the recurrent swelling took on a two-week cycle. After six months of menstrual periods she had an amenorrhoea of six months during which time she had no trouble with her knee, but on

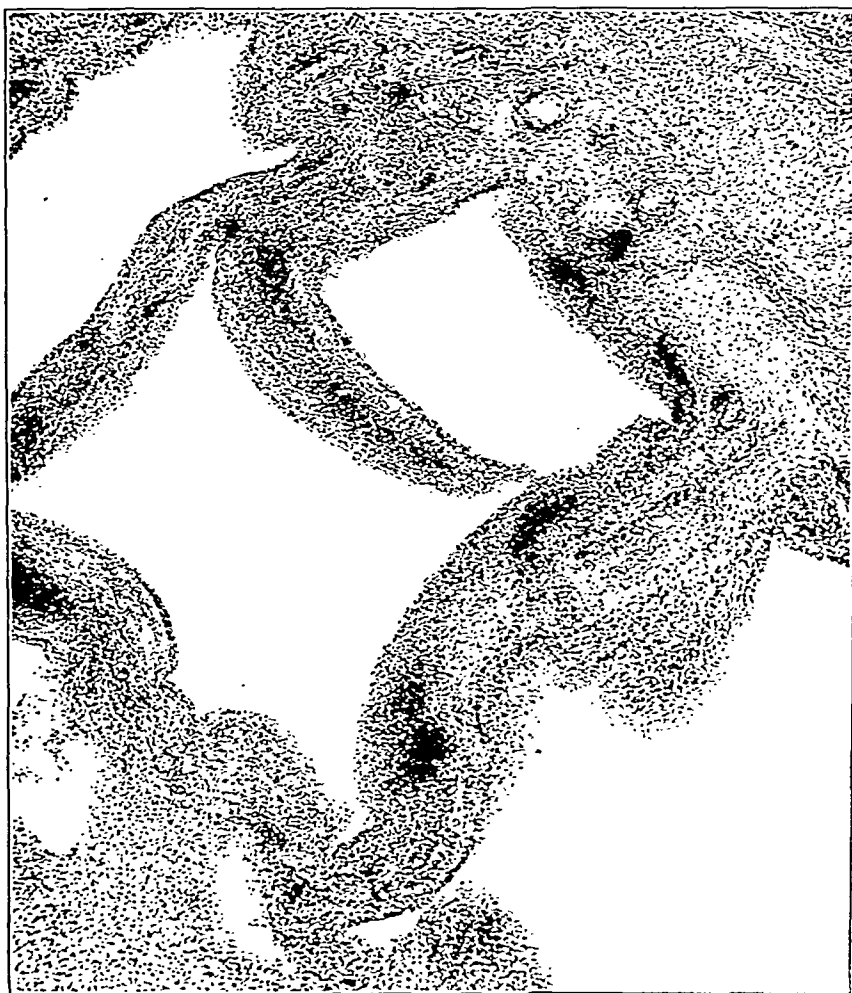


FIG. 6

From the second case, showing the slender slanting villi. This operation was done in a quiescent interval.

resumption of menstruation the former periodicity recurred. This cycle continued for one year, when, without cause, the cycle changed to eleven days.

Ten months previously she had had both semilunar cartilages removed at another hospital, without any effect on the swelling or periodicity. She had likewise had aspirations without any effect.

On July 8, 1931, during a quiescent interval, the left knee joint was opened by the general utility incision. A congested synovial membrane was excised, and the joint was closed in layers.

The postoperative course was uneventful, except that a considerable restriction of movement remained, which was somewhat improved by a subsequent manipulation under anaesthesia. Eight months after operation, the joint movement was from 15° to 120 degrees; there had been no recurrence of the effusion in either knee.

The report of the microscopic pathology as made by Dr. John E. MacWhorter was as follows:



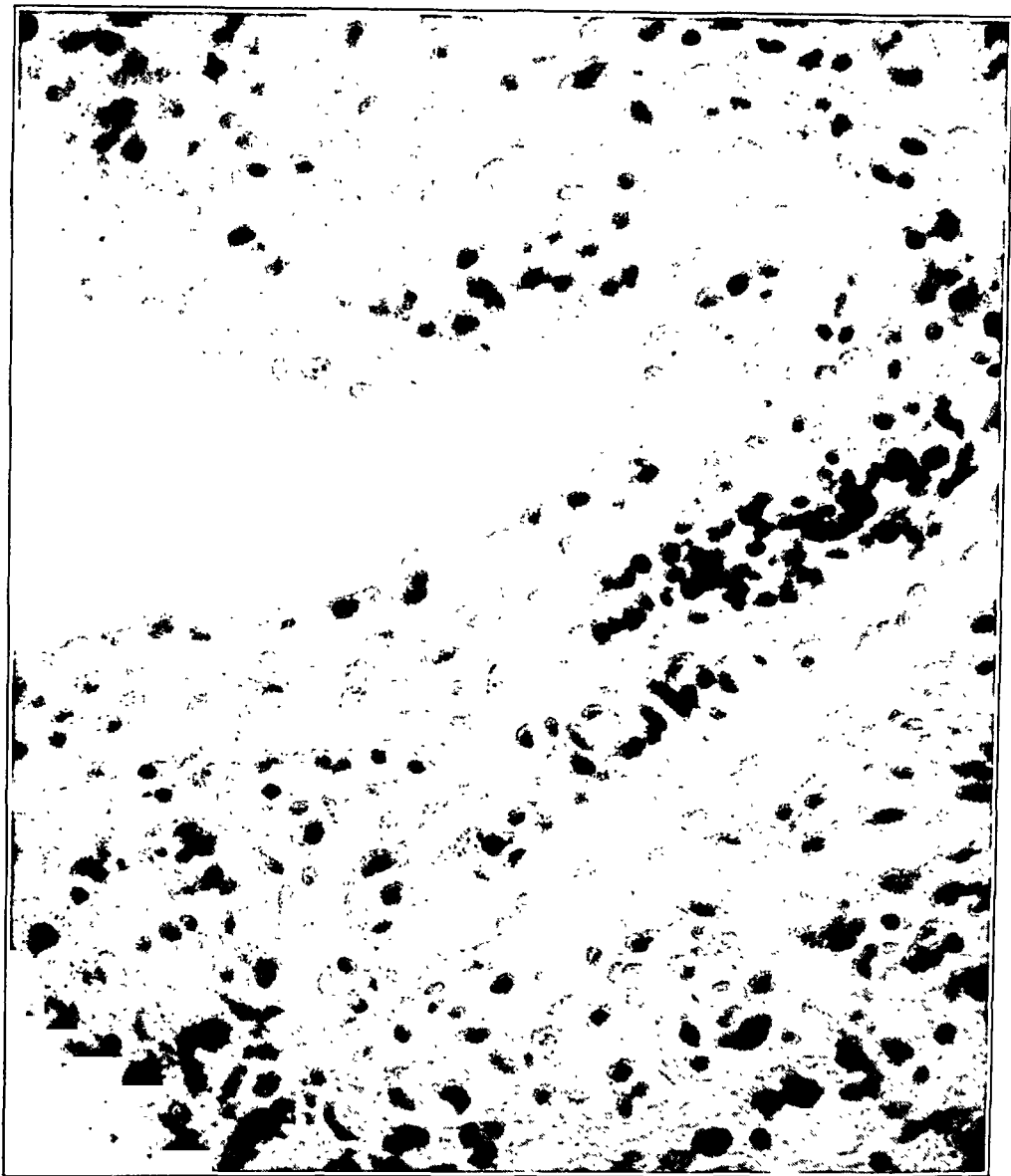


FIG. 7

High-power photomicrograph of the synovial membrane from Case 2.

*Case 1*

"Surg. Path. No. 858, Hospital for the Ruptured and Crippled. The sections show that the synovial surface is arranged in the form of somewhat flattened villi. The villi are made up largely of rather recently formed granulation tissue which is characterized by many endothelial line blood spaces and young connective-tissue cells of the fibroblastic type. The tissue as a whole is rather strikingly oedematous. There is a diffuse and profuse infiltration with lymphocytes in the villi and in the tissue immediately below the synovial surface.

"The rest of the section is made up of dense connective tissue, adult fat, and many sclerotic blood vessels.

"The small tumor mass from the calf consists of dense connective tissue and cartilage.

*Case 2*

"Surg. Path. No. 1949/31, Bellevue Hospital. Sections show the synovial surface covered with villi which for the most part are long, slender and branching. Structurally

they are made up of fairly firm, moderately adult connective tissue and rather thick-walled blood vessels. This tissue as a whole is only slightly oedematous, and is but moderately infiltrated with round cells. The round-cell infiltration is confined almost entirely to the villi.

"The rest of the section consists of dense connective tissue, fat, and thick blood vessels.

*Remarks upon the Comparison of Sections from the First and Second Cases*

"The manner in which the two sections differ is this: sections of the first case are characterized by flattened villi, recently formed granulation tissue, oedema, and very profuse round-cell infiltration.

"The second case is characterized by long, slender villi, well formed connective tissue, only slight oedema, and very moderate round-cell infiltration.

"In the first case, there is present an active process; in the second, the picture is one of inactivity."

#### SUMMARY AND CONCLUSIONS

Intermittent hydrarthrosis in general has hitherto been regarded as a medical curiosity of unknown pathogenesis and in which treatment has been decidedly unsatisfactory.

Two typical cases of intermittent hydrarthrosis of the knee joint, of diverse etiology, are reported in which apparent cure was obtained following the operative removal of the synovial membrane.

The etiology in the first case was definitely traumatic, and the condition was associated with a fibrous tissue mass in the calf muscle, the probable origin of this mass being a hematoma of that region. The attacks were of nine months' duration, came on five weeks after the traumatism, and persisted despite aspiration, rest in bed, and autoserotherapy. No clinical hypersensitiveness could be demonstrated in the history or by exhaustive tests.

The etiology in the second case was obscure, but definitely related to menstruation. The semilunar cartilages had been removed at another hospital. She had had repeated aspirations without effect.

Despite the fact that rarely recurrences of this disorder may take place after long intervals, it is nevertheless felt that, on the basis of the above observations, synovial excision offers the best prospect for the cure of the condition.

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# THE BIFURCATION OPERATION \*

## A STUDY OF LATE RESULTS

BY CHESTER S. LOWENDORF, B.S., M.D., YOUNGSTOWN, OHIO

The bifurcation operation, because of the simplicity and rapidity by which it may be performed, is not a formidable procedure. It should not, however, be used indiscriminately for all hip diseases. But, when the dangers of extensive operations become too threatening, it may be used as a substitute for the more anatomical reconstructions.

This report concerns the late results from fourteen cases in which the bifurcation operation was performed in the Orthopaedic Department of the State University of Iowa. It is hoped that the analysis will aid in indicating the advantages and the limitations of this palliative method.

### *Indications*

The bifurcation operation was performed first in cases of irreducible congenital dislocation of the hip, when no other means was available for placing the femur firmly underneath the bony pelvis. Since then the field has been enlarged to include ununited fractured neck of the femur, osteoarthritis of the hip, suppurative arthritis with pathological dislocation. Others have also included quiescent tuberculous hips and Charcot hips; but we do not make these indications for reasons that will be brought out later. Among these various conditions we are faced with a common symptomatology that requires urgent relief. Uniformly we find pain on motion, instability upon weight-bearing, and deformity.

Other reconstructive measures alleviate these symptoms in these hip conditions, but such operations entail an additional risk which the general status of the patient may not permit. It has been shown that the more extensive operations carry a greater risk. In an analysis of our Whitman reconstruction operations, which was recently published, it was found that only seven of sixteen patients had an uneventful convalescence. There was no shock following any of our bifurcation operations. Elderly patients with hypertension, arteriosclerosis, and nephritis are usually considered poor surgical risks. Yet among the patients of this series there were two with a systolic pressure of 200 and several with marked arteriosclerosis. One patient was sixty-seven years old. The average age of those operated upon for non-union of fractured neck of the femur and osteoarthritis of the hip was fifty-eight. The bifurcation operation carries so little danger that it can be performed on patients where other operations might be contra-indicated.

The amount of bony tissue still available for weight-bearing is another important factor in considering operative indications. The average length of time before operation, in our patients with fractured neck of the

\* From the Department of Orthopaedic Surgery, State University of Iowa, Iowa City, Iowa.

femur, was nine months. During this time the neck had partially or completely absorbed. The head and most of the neck were destroyed in suppurative arthritic cases of this series. Under such circumstances anatomical reconstruction is nearly impossible.

### *Contra-Indications*

In this clinic, we have had only two cases of Charcot hip and two cases of quiescent tuberculous hip upon which the bifurcation operation has been performed. This is too small a number for giving a definite opinion in opposition to opinions based on larger series. However, since both tuberculous patients developed sinuses that have been open for years, and since, in both cases of Charcot hip, the acetabula disintegrated progressively above the supporting fragment of the femur, again leaving no bony support, we would naturally hesitate to recommend the operation in these conditions.

It has been mentioned elsewhere that the bifurcation operation is a simple arthroplasty, a pseudarthrosis between the pelvis and femur with the former capsule as the interposing tissue; nevertheless, this operation can not be performed upon ankylosed hips; the entire femur must be movable in order that the proper results may be obtained. This operation will not in any case increase the motion over that already present.

### *Complications*

To prevent most of the possible complications, strict attention must be paid to the details of the operation. Probably the most common complication is unnecessary shortening. This may occur if the osteotomy is performed too low on the shaft of the femur. Then, in order to obtain bony support, considerable displacement becomes necessary. The possibility of injury to femoral vessels appears great to many observers. Yet, among our own cases and in those of the literature, we find no evidence that such a complication has actually occurred. Care in the selection of site of osteotomy and in the manipulation following osteotomy, during which one guards against hyperextension, is all that is required to prevent such a disaster.

While it is common knowledge that fractures in and about the intertrochanteric region usually heal with bony union, still non-union may occur. This complication has occurred in a very small percentage of cases recorded in the literature. We have had only one case of non-union and that occurred in a patient with a tuberculous hip, who also developed a persistently draining sinus.

Failure to have the femur support the pelvis is due to failure to properly perform the operation. Infinite care must be exercised, so that the osteotomy is not too high on the femur and so that the displacement of the lower fragment is accomplished; otherwise, the necessary bifid effect is never obtained. If the osteotomy should be placed too high, then the lower fragment, following displacement, would not abut the bony surface

of the pelvis. If no or improper displacement should occur, then the femur would also fail to fall under the weight-bearing line. Such errors in technique occurred in five cases among our original list, and, since they were really not bifurcation operations to begin with, they have been excluded in this study.

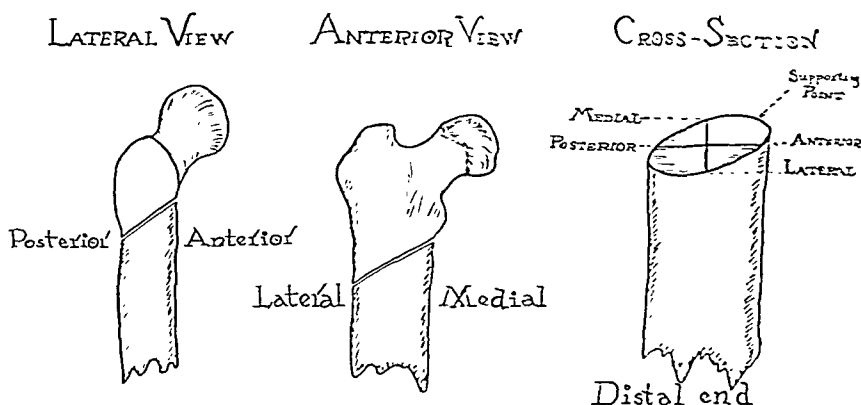


DIAGRAM I

The direction of the osteotome and the plane of osteotomy.

### *Procedure*

The principles of this operation are exceedingly simple. However, one must recognize that exact knowledge of every phase of the operative technique is necessary and that this technique must be applied with the utmost precision. It is with this fact in mind that I repeat the details of the operation, which has already been described in the literature.

First of all, one plans the location of the osteotomy with the aid of the x-ray plate. In order to do this properly, the exact point on the pelvis, which is to receive the support of the femur, must be determined. This pelvic point of support varies with each individual and with the pathological condition present. It, therefore, may be the center of the acetabulum, as in the case of a dislocated femur, or the lower border of the acetabulum, or the lower edge of the head, as in ununited fractured neck of the femur or osteo-arthritis of the hip. The next step in determining the location of the osteotomy is to decide where the supporting point of the femur should come. This point, on the roentgenogram, is a point on the medial side of the femur, horizontally opposite the above mentioned point on the pelvis. If this femoral point should be too low, then unnecessary shortening would result. The relation of this point to other structures is of no importance. As Hass states, "The site of osteotomy according to the femoral head varies, but is decided quite accurately in every instance". One is now ready to draw a line on the roentgenogram, obliquely downward and laterally across the shaft of the femur. The degree of angulation required is approximately forty-five degrees or less. In order to properly carry out such well laid plans during the operation, a probe may

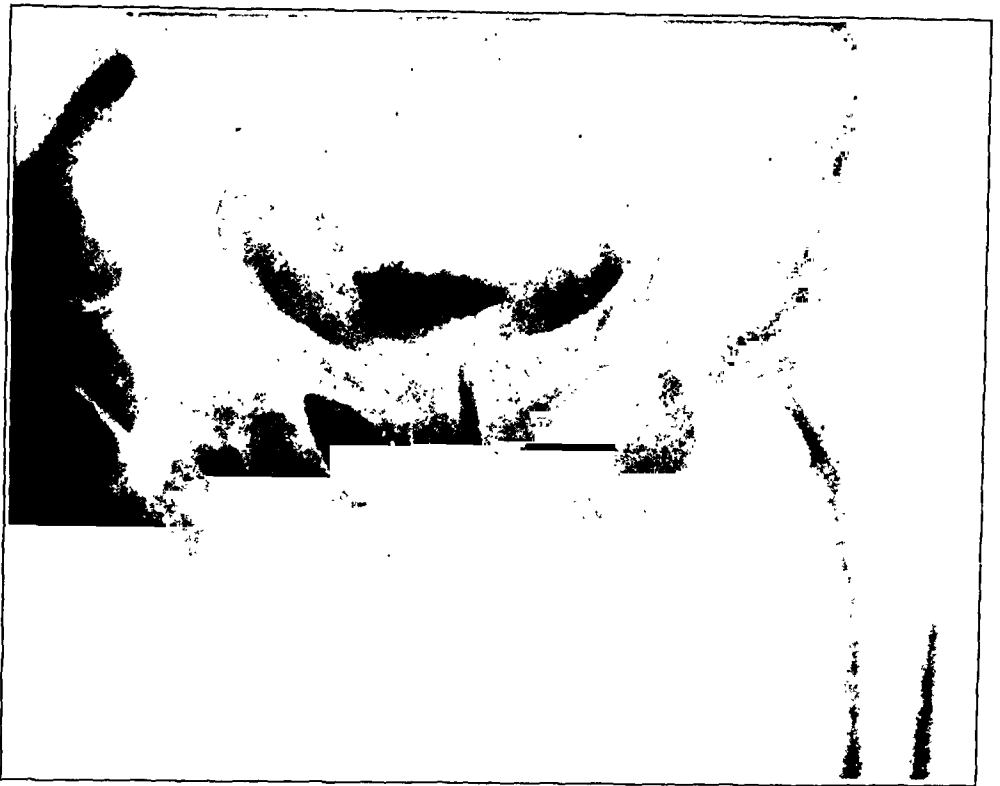


FIG. 1

R. F., aged fifty-five, fracture. Bifurcation intertrochanteric, no pain, negative Trendelenberg, good motion, no increased shortening. Good result. Final roentgenogram.

be bent from the tip of the greater trochanter down along the shaft and along the proposed site of osteotomy. This probe may be sterilized and inserted over the femur at operation.

At operation the patient is placed on the opposite side, so that the operative field shall be above. A linear incision is made over the lateral surface of the femur so as to expose the tip of the greater trochanter and several inches of the shaft. After the periosteum has been elevated, the probe is placed in the wound approximately in the same manner that it had been on the roentgenogram. Thus, the beginning and the angulation of the osteotomy line are established. However, the osteotomy is formed obliquely in the frontal, sagittal, and transverse planes. Therefore, the osteotome must be rotated so its anterior border is superior to its posterior border, while at the same time it is tilted in order to be driven in and up. In other words, the chisel travels from lateral, distal posteriorly to median, proximal anteriorly. The result will be a large, elliptical raw surface (See Diagram 1). The femoral point for supporting the pelvis is in reality the anteromedian pole of the ellipse. The need for an ellipse with an anteromedial direction is not obvious. It is clear that an oblique osteotomy with the point anterior would be useless; but one must remember also that the shaft of the femur is not in the same frontal plane as the head. There is normally about twenty-five degrees of anteversion to the neck of

the femur, and the axis of the head of the femur runs forward, upward, and inward with respect to the shaft. Since the shaft is behind the acetabulum, normally and under pathological circumstances, the anterior angulation, or the tilt in the sagittal projection of the osteotomy, is quite necessary. The degree of anterior tilting of the osteotomy varies, accordingly, as to whether the acetabulum is empty or contains the femoral head.

After the osteotomy is completed, the thigh is abducted with one hand, while the upper portion of the lower fragment is pressed medially with the thumb of the other hand. Upon this manipulation the shaft of the femur glides past its upper fragment. When the femur has been displaced a fraction of an inch, one will note that it will override no further for it now rests underneath the bony ledge of the pelvis. The wound is then closed in layers.

The patient may now be carefully turned on his back in order to apply a plaster cast. The extremity is placed in abduction, which varies from thirty degrees in cases of ununited fractured neck of the femur to fifteen degrees in cases of osteo-arthritis. Slight internal rotation is advisable, since there is a tendency to develop an external rotation deformity. The thigh is left in neutral position in the sagittal plane, special care being taken to prevent hyperextension. It is customary in this clinic to apply a double hip spica with a short torso, instead of a high single spica, since the former allows greater freedom of the chest and abdomen.

The ordinary postoperative care is required. The patient remains in his first cast six weeks to two months. Then, according to the roentgenographic evidence of the degree of bony fusion, another single hip spica is applied, and the patient is allowed on crutches but without weight-bearing; or physiotherapy is instituted for another month. In approximately three months the patient gradually commences weight-bearing.

Fourteen bifurcation operations were available for study in this series; they have been personally observed over an average period of twenty-seven months. These operations had been performed by Dr. Steindler and his staff. Excluded are only the atypical osteotomies with their various individual modifications.

The immediate postoperative convalescence in these cases was uniformly uneventful. No shock occurred following the operation. There was no circulatory disturbance due to the operation. Pneumonia developed in one patient who was an exceedingly poor risk and presented bilateral Charcot hips, a Charcot ankle, and tabes dorsalis.

The relationship of the osteotomy site with the lesser trochanter has concerned several writers. We found, upon examining postoperative roentgenograms, that there were five subtrochanteric and nine intertrochanteric osteotomies. There was no relation between these findings and the functional outcome of the operation.

Since it has been customary in this clinic to use other methods, no cases are reported here of the bifurcation operation for old congenital dis-



located hips. Yet the bifurcation operation was indicated primarily for this condition and it is thus used successfully elsewhere. Our series included six cases of ununited fractured neck of the femur, two of osteoarthritis of the hip, two of suppurative arthritis with pathological dislocation, two of the Charcot hips and two of tuberculous hips.

### *Painlessness*

The relief from pain and instability, which the bifurcation operation affords, is its chief advantage. The patient's trouble of this nature is due to the elastic suspension of the body weight upon the soft tissues over the end of the femur. Notwithstanding the theoretical objections that have been raised, it is the experience of others, and of this clinic, that the pressure from the new supporting surface of the femur against the old capsule or the pelvic periosteum does not cause pain. Eleven of the fourteen cases reported were completely freed from pain by the operation. The other three, which were among the failures, had less pain than before operation, although it was not entirely absent.

### *Stability*

The stability which followed the operation was so greatly improved in most cases that nine of the fourteen cases needed no support whatever. Two patients had a negative Trendelenberg sign. Crutches were still necessary for two patients with fractured hips, one with a Charcot hip, two with tuberculous hips. The two Charcot hips were the only ones that permitted telescoping postoperatively.

### *Mobility*

While this operation does not afford the amount of mobility that is often possible in the nicer anatomical reconstructions, still a useful range of motion is usually obtainable. A flexion contracture of approximately fifteen degrees was present in most of the cases, but there were no other contractures. The operation did not increase the amount of motion over the preoperative range, but it did correct the preexisting deformities. The least motion resulted among the osteo-arthritic cases. But these patients had very little useful movement before their operation. The abnormal mobility in the two Charcot hips was a disadvantage, since the hips could telescope and could not be voluntarily controlled. The preoperative range of motion was nearly all retained in the tuberculous cases.

### *Shortening*

A reasonable amount of shortening is to be expected following any reconstruction operation on the hip. The average shortening due to this operation in the eight fracture and osteo-arthritic cases, was one-quarter of an inch. In return for the improved alignment of the extremity, this is a negligible quantity. Because of the disintegration of the acetabulum in the two Charcot hips, and the resultant excursion and telescoping, there



FIG. 2-A

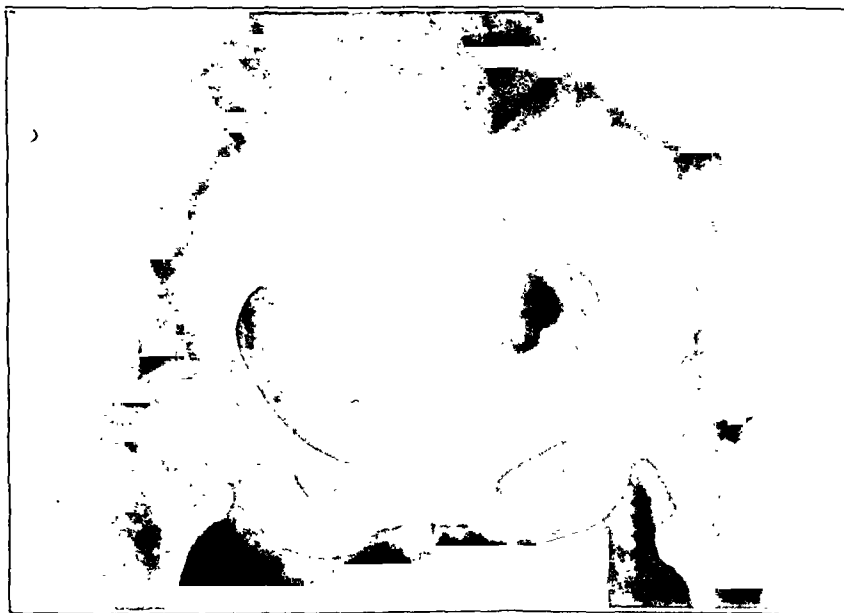


FIG. 2-B

A. W., aged sixty-seven, fracture. Bifurcation intertrochanteric, no pain, good stability, fair motion, one-half inch increased shortening. Good result.  
Fig. 2-A. Before operation Fig 2-B. Final roentgenogram.

was shortening averaging three inches. From our inability to determine on the roentgenogram the exact point on the pelvis where the femur would find anchorage, there occurred perhaps more shortening in the cases of suppurative arthritis with pathological dislocation than otherwise would have been the case. Yet the beneficial postoperative features obviate such slight disadvantage as the increased shortening produced.

### *End Results*

The end results of these fourteen cases may be determined on the consideration of the relief of pain, the stability, the alignment, the mobility, and the shortening that followed the operation. One must also remember the poor preoperative condition that many of these patients presented, and remember that the bifurcation operation was indicated as a last resort. Eight among the fourteen cases may be classified as having a good functional result. The bifurcation operation gave a good result in all osteo-arthritic and pathological dislocated hips. It failed in all Charcot and tuberculous hips. One patient with a fractured neck of the femur is now able to walk three miles a day without discomfort. Others follow their occupation with little impediment. Most of them notice certain little incapacities,—*e.g.*, putting on their shoes.

### *Analysis of Poor Results*

From the type of patients considered here, it would be too much to expect any operation to be a panacea. It is, therefore, not surprising that six of the fourteen cases were failures. Careful analysis of each case may reveal the reason for failure to improve by operation. Two patients with fractured neck of the femur failed to be improved by the bifurcation operation. One of these was an obese, diabetic man of fifty-three, who had a mid-thigh amputation of the opposite extremity and an arthrodesed knee on the side of the fractured hip. Following operation, he is still confined to crutches and still has pain in his hip. The other patient, a woman of sixty-four with generalized arteriosclerosis and hypertension, was a poor surgical risk. Although she withstood the operation markedly well and without any shock, two weeks later she complained so bitterly of pain in both heels that the cast was changed. Unfortunately the fragments slipped slightly following this procedure. A year after operation she still complains of pain in her hip and heels and refuses to walk without crutches. However, careful clinical examination fails to account for her subjective findings.

The roof of the acetabulum in each of the Charcot hip cases disintegrated following the operation, and thus the supporting portion of the femur dislocated from the resulting shallow acetabulum. We had a similar experience with the Whitman reconstruction operation in this condition. It is now felt by us that all reconstructive measures are contraindicated in Charcot hips, since the motion that results is not controlled, and the stability is only temporary.



FIG. 3-A



FIG. 3-B.

S. K., aged twenty-three, suppurative arthritis with pathological dislocation, separation of symphysis pubis. Bifurcation subtrochanteric. No pain, good stability, good motion, one and one-half inches increased shortening. Good result.

FIG. 3-A. Before operation. FIG. 3-B. Final roentgenogram.

TABLE I  
SUMMARY OF CASES

	<i>Ununited Fractured Neck of Femur</i>	<i>Osteo- Arthritis of Hip</i>	<i>Suppurative Arthritis with Pathological Dislocation</i>	<i>Charcot Hip</i>	<i>Tubercu- lous Hip</i>
Number of cases . . .	6	2	2	2	2
Average age . . . . .	58	59	18	35	17
Sex:					
Male . . . . .	2	1		1	
Female . . . . .	4	1	2	1	2

Average length of observation—27 months

TABLE II  
POSTOPERATIVE FINDINGS

	<i>Ununited Fractured Neck of Femur</i>	<i>Osteo- Arthritis of Hip</i>	<i>Suppurative Arthritis with Pathological Dislocation</i>	<i>Charcot Hip</i>	<i>Tubercu- lous Hip</i>
Roentgenogram of os- teotomy site:					
Subtrochanteric. . .	1		2		2
Intertrochanteric. .	5	2		2	
Pain:					
None . . . . .	4	2	2	1	2
Slight . . . . .	2			1	
Support needed:					
None . . . . .	4	2	2	1	
Crutches . . . . .	2			1	2
Average range of motion:					
Flexion . . . . .	55 degrees	10 degrees	35 degrees	90 degrees	60 degrees
Abduction . . . . .	20 degrees	0 degrees	30 degrees	30 degrees	30 degrees
Adduction . . . . .	10 degrees	0 degrees	0 degrees	35 degrees	20 degrees
Rotation . . . . .	0 degrees	0 degrees	10 degrees		20 degrees
Average shortening . . . . .	$\frac{1}{4}$ inch	$\frac{1}{4}$ inch	$1\frac{1}{2}$ inches and 3 inches	3 inches	No data
End Results:					
Good . . . . .	4	2	2		
Failure . . . . .	2			2	2

Average flexion contracture—15 degrees

Our results in quiescent tuberculous hips were sad. One such hip, with a calcified intrapelvic abscess, was bifurcated, but a sinus later developed, which has been draining for six years. In the second tuberculous hip operated upon by this method, a sinus developed, now of eighteen months' duration, and the fragments of the osteotomy also failed to unite. Although Hass gives sixty-six per cent. of good and thirty-four per cent. of

sufficient results in a much larger series of tuberculous cases, nevertheless, under our own circumstances, we must hesitate to recommend the bifurcation operation in this condition.

## SUMMARY

This is a study of results of the bifurcation operation in fourteen cases. The procedure is a palliative measure which has a definite field of indications. It is a simple method, carrying little surgical danger, but requiring strict attention to details in order to obtain good results. The series here reported included patients with fractured neck of the femur, osteo-arthritis of the hip, dislocated hip, Charcot and tuberculous hips. Eight good results were obtained by this operation.

It is with sincere appreciation that the writer acknowledges the privilege of preparing this report and the guidance shown him by Dr. Steindler.

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# FRACTURE SEPARATION ("SLIPPING") OF THE LOWER FEMORAL EPIPHYSIS

## REPORT OF A NEW PROCEDURE FOR REDUCTION

BY EDWARD P. HELLER, M.D., KANSAS CITY, MISSOURI

*Attending Surgeon, Orthopaedic Department, Kansas City General Hospital*

Slipping of the lower femoral epiphysis is not a very rare accident and invariably occurs before the twenty-first year. The difficulties encountered in reduction are only second in importance to the possible damage to the popliteal vessels in the original accident, or by the manipulative attempts of the surgeon.

So far as the author is able to discover there is nothing in the literature comparable to the technique employed in the case reported below. The usual method is to try horizontal extension and manipulation. Failing in this, various manoeuvres—such as that of Hutchinson and Barnard<sup>1</sup>—are usually tried, or traction on a double inclined plane. In a rare case open operation is done.

Kurlander<sup>2</sup> of Cleveland re-

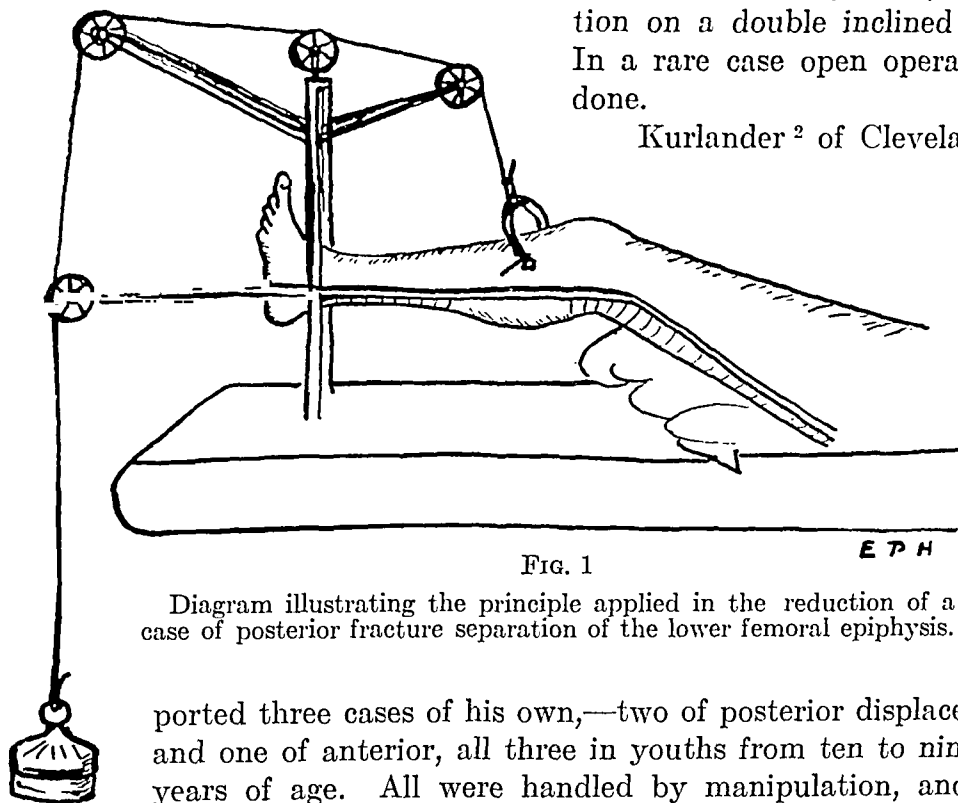


Diagram illustrating the principle applied in the reduction of a case of posterior fracture separation of the lower femoral epiphysis.

ported three cases of his own,—two of posterior displacement and one of anterior, all three in youths from ten to nineteen years of age. All were handled by manipulation, and one later required amputation through the lower thigh, after gangrene had developed from injury to the popliteal vessels following two attempts at reduction under general anaesthesia. He called attention to the few reported cases of this fracture and to the fact that none of the standard American texts described the condition or its treatment except Scudder. Manipulation was the only treatment suggested. This

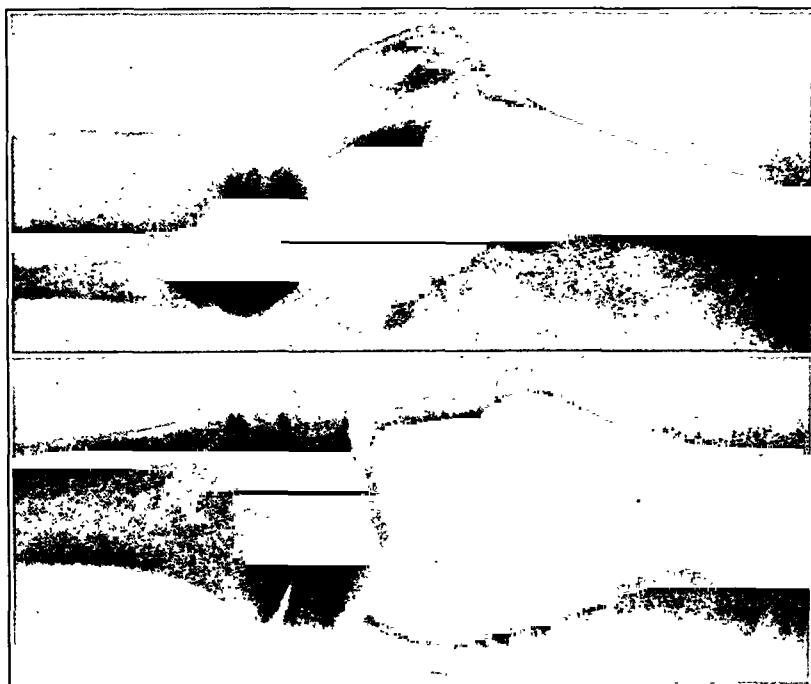


FIG. 2

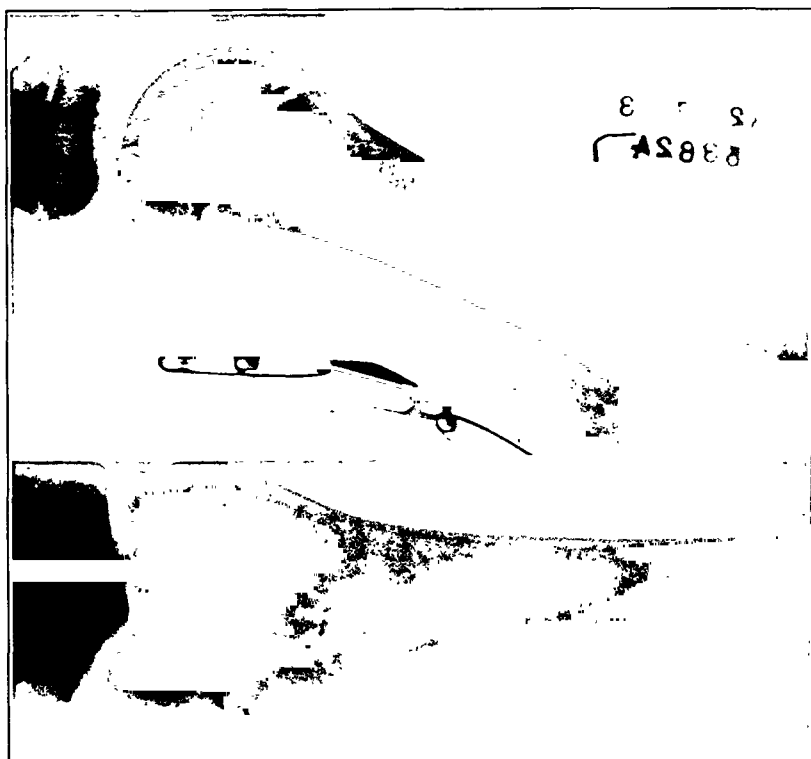


FIG. 3



is, therefore, the only case known to the author in which a skeletal traction procedure has been used.

F. K., boy aged twelve, Kansas City General Hospital No. 36532, admitted to children's ward of Kansas City General Hospital December 2, 1931. Roentgenogram showed: ". . . fracture of the lower end of the left femur entering into the epiphyseal junction. The epiphysis and medial condyle are displaced inward and backward" (See Figure 2).

The extremity was at once placed on a Böhler frame, with adhesive traction from the knee down, in the hope that traction on a two-plane principle would effect some reduction. When it became apparent that no good was being accomplished, thirty-six hours after admission, a Kirschner rustless wire was passed through the upper tibia, and the weight cord rigged as shown in the illustration. Under primary ether anaesthesia in the dressing room attached to the ward, upward pull was exerted, while a house doctor kept firm pressure on the shaft of the femur as it lay on the Böhler frame. Reduction was simple and, as shown in Figure 3, complete. The boy was allowed to remain in traction, with the splint rigged as shown, for a period of twelve days, when it was deemed safe to remove him from the traction apparatus, apply a cast, and send him home.

At no time was the boy in any discomfort as a result of the Kirschner pin or the attached traction. The system used was not calculated to endanger the popliteal structures in any way, and is in marked contrast to the manipulative method reported by authors up to the present time.

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# SLIPPING OF THE UPPER FEMORAL EPIPHYSIS \*

## TREATMENT IN THE PRE-SLIPPING STAGE

BY S. A. JAHSS, M.D., NEW YORK, N. Y.

Although many forms of treatment for this condition in the pre-slipping stage have been tried, the end results have not been consistently good. These treatments have consisted of rest in bed, with or without traction, plaster spicas, braces, and, finally, drilling of the epiphyseal plate with the introduction of bone slivers. The last procedure cannot be considered a conservative measure.

The time element and the possibility of further slipping are the two most important objections to these procedures. As long as the head remains loosely attached to the neck, it may become displaced. Why this takes place is still unknown, but the fact remains that such is the case.

It is a known fact that all cases of slipping epiphyses heal eventually. This can only be explained by assuming that the continued trauma of slipping causes a premature ossification of the epiphyseal plates of the head and neck. This reason may seem far-fetched, but it has been seen in cases of injury to the epiphyses of the lower end of the humerus with the resultant deformity of either cubitus varus or cubitus valgus.

The idea of supplying trauma then presented itself and the following method was evolved.

### *Traumatization of the Epiphyseal Line*

With the patient fully anaesthetized, the limb is brought into a position of full extension, slight *internal rotation* and about ten degrees of *adduction*. In this position the greater trochanter is most prominent. A piece of thick, heavy felt is placed over the greater trochanter and part of the shaft. Two strips of adhesive plaster hold it in position. An assistant stands on the opposite side of the patient and exerts counter-pressure on the pelvis and thigh of the normal side. By means of the Cotton hammer, four or five rather vigorous blows are struck. The direction of the force is in the line of the neck. The trochanter receives the brunt of the trauma, which is transmitted through the neck to the epiphyseal line. The limb is then immobilized in a long plaster spica in a position of about 170 degrees, full abduction, and slight internal rotation.

### *After-Treatment*

After one week the patient is allowed to walk with the aid of crutches. The shoe on the normal side is raised. After three months the plaster is bivalved and active treatment, consisting of diathermy, massage, and

\* From the service of Dr. Herman C. Frauenthal.



FIG. 1

Fragmentation and marked absorption of the neck for a depth of one-half inch. Marked widening of the epiphyseal line.

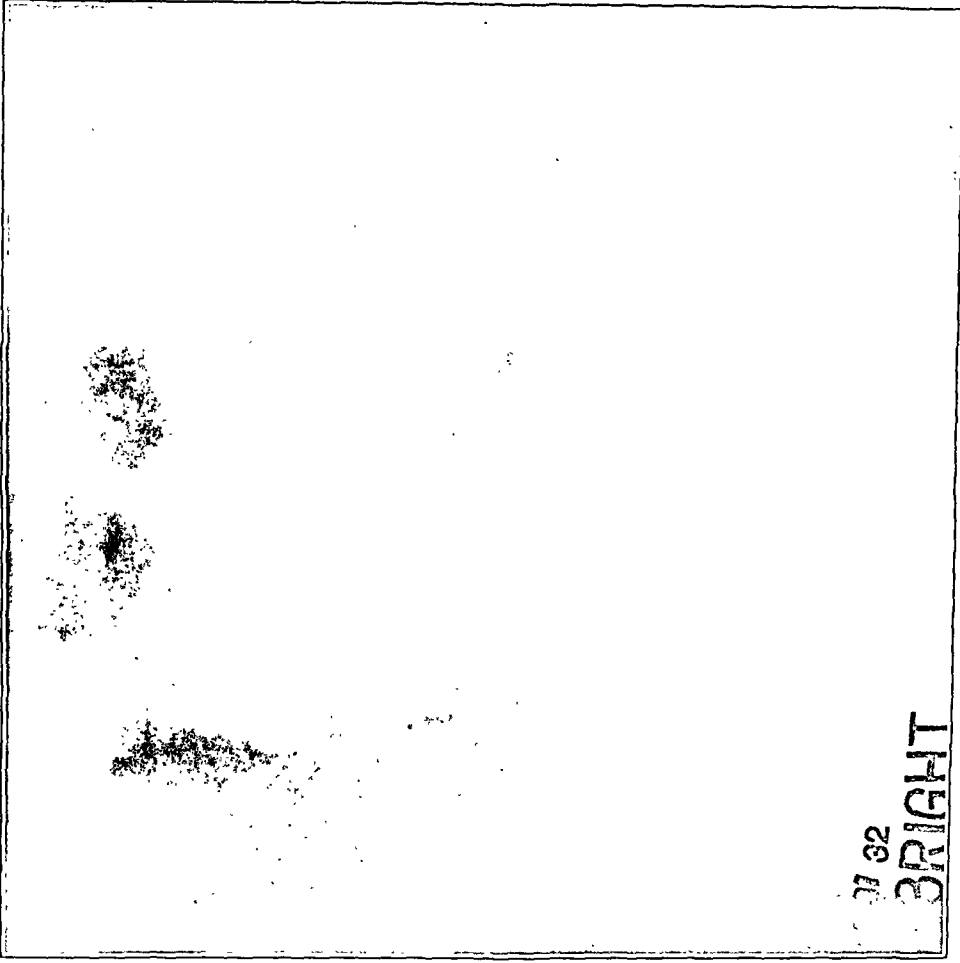


FIG. 2

The fragmentation has disappeared. There is a normal epiphyseal line with ossification at its central portion.

active motion is instituted, if there is occasion for it. In the three cases here reported, two needed no treatment, whereas the third required only two weeks of treatment. Further protection of the hip is not entirely necessary at this time. As a measure of caution, the patient may be asked to wear a Thomas walking caliper brace for a short time.

#### CASE REPORTS

**CASE 1.** C. M., male, twelve and one-half years of age. Child began to limp about the middle of July, 1931; at that time, there was no pain associated with the limp. The child, however, tried to favor that extremity. This limp lasted only one day, after which he again walked normally. He was then sent to camp for three weeks. During the last week at camp, he again developed a painless limp for one day. After returning to the city, he limped for three days (third week in August). In September, this happened again. These attacks of limping had followed violent exercise, and had always been transitory.

*Physical examination* revealed a thin, well developed youngster, not acutely ill. He walked with a limp, body being tilted about fifteen degrees to the left every time weight was borne on the left lower extremity. Motion at the left hip was practically normal in range; there was a slight restriction of internal rotation. He was admitted to the Hospital for Joint Diseases on September 18, 1931.

*Roentgenographic examination on admission* (Fig. 1) showed a widening of the epiphyseal line and fragmentation of the epiphyseal end of the diaphysis. There were irregular areas of absorption for a distance of one-half inch distal to the epiphysis; no slipping of the epiphysis proper.

*Operation* on September 28, 1931. Readmitted on January 7, 1932.

*Roentgenographic examination* (Fig. 2) at this time revealed no fragmentation, a rapid filling in of the areas of absorption, the appearance of a normal epiphyseal line with ossification at its central portion.

*Physical examination* a few days later revealed a normal range of motion at the hip.

**CASE 2.** J. L., male, fourteen and one-half years of age. Chief complaint, limp; duration, three months. About four months ago, while standing on a bed spring, patient's left leg slipped through an opening in the spring. He fell but apparently did not injure himself. Three months ago he began to limp but had no constant pain. On arising from a sitting position, patient experienced pain in his left hip, but this pain gradually diminished and finally would disappear after walking a short distance. The limp, however, persisted, but had not become more pronounced since its onset three months before. He was admitted to the Hospital for Joint Diseases on October 2, 1931.

*Physical examination* revealed an obese boy, white, "Fröhlich" type, not acutely ill. Weight, 157¾ pounds. He walked with a limp, body tilting fifteen degrees to the left. Angle of greatest extension 180 degrees, angle of greatest flexion 70 degrees. Abduction 35 degrees, adduction 15 degrees, external rotation 45 degrees, internal rotation 0. Limbs were equal in length.

*Roentgenographic examination* (Fig. 3): Absorption of the neck distal to the epiphyseal line, more marked in its lateral portion. No slipping of the epiphysis.

*Operation* on October 5, 1931. Readmitted on January 7, 1932.

*Roentgenographic examination* (Fig. 4) at this time showed complete union between the head and neck of the femur; no area of absorption.

On January 30, 1932, patient slipped and fell, sustaining a traumatic synovitis of the left knee. Motion at the hip remained unimpaired and there was no pain in the hip. At this time full motion at the hip was present.

Having had such gratifying results with these very early cases, it was decided to apply the same form of treatment when a case with mild slipping presented itself. Inasmuch as the shortening was about one-half of one inch and the range of motion fairly



Fig. 3

Note the absorption, particularly in the lateral portion of the neck, just distal to the epiphyseal line.



Fig. 4

Shows complete ossification of the epiphyseal line.



FIG. 5

Note the pronounced absorption of the neck just distal to the epiphyseal line.

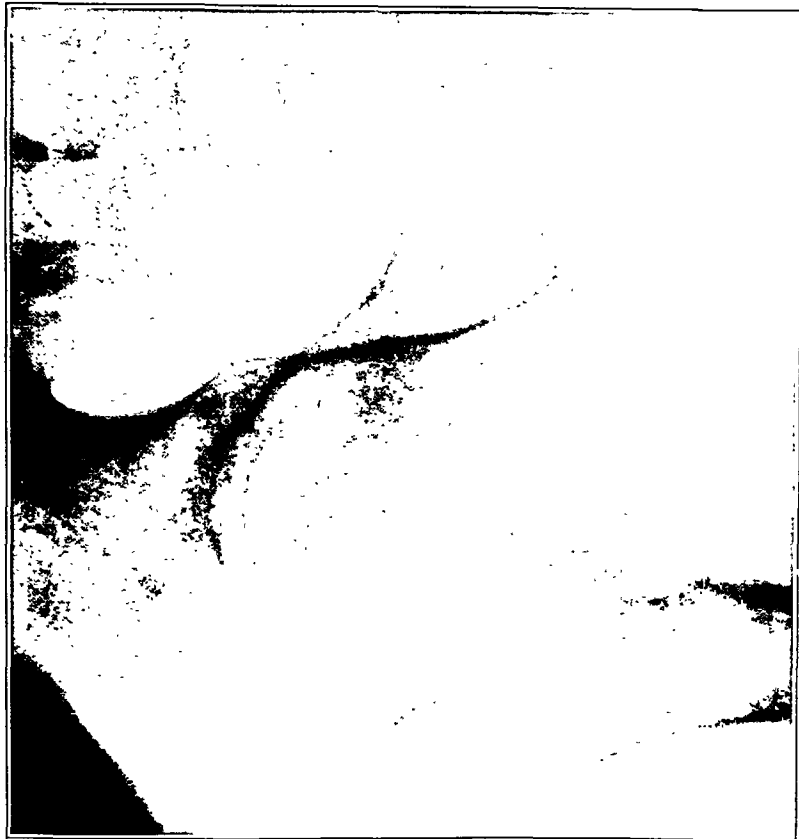


FIG. 6

Entire absence of absorption with complete union of the epiphysis to the neck.

good, it was thought that it would be best to obtain union with the slight slipping, rather than to attempt to break up the insecure union of the head to the neck and then manipulate it to obtain perfect anatomical replacement.

CASE 3. D. K., female, ten years of age, white. Chief complaint, limp.

*History:* Five months prior to admission to the hospital, she slipped, while skating, striking her right hip against the pavement. Three days later she complained of pain in the hip, which gradually subsided in about three days. One week later the pain returned for a period of three days and then subsided completely. One month ago the child began to limp but had no pain except when she took the first few steps or after sitting for a considerable length of time. She also complained of a tired feeling in the hip after walking short distances. She was admitted to the Hospital for Joint Diseases February 5, 1932.

*Physical examination* revealed an obese female of the "Fröhlich" type. As the child walked, there was a tilt of the body to the right of twenty-five degrees. The Trendelenberg sign was positive on the right. The right lower extremity was held in a position of twenty-five degrees of external rotation. From this point it was possible to internally rotate the limb fifteen degrees. Therefore, there was a ten degrees' external rotation deformity present. Internal rotation was 0; external rotation, normal. Angle of greatest flexion 70 degrees, angle of greatest extension 180 degrees. Abduction 35 degrees; adduction 20 degrees. Length of the left lower extremity was thirty and three-quarters inches; length of the right lower extremity, thirty and one-quarter inches.

*Roentgenographic examination* (Fig. 5) at this time showed a slight lateral displacement of the neck, condensation of the epiphyseal line (the result of posterior rotation of the head, causing an overlapping of the head on the neck), absorption of the neck just distal to the epiphyseal line, more pronounced at its medial aspect.

*Operation* February 8, 1932. Readmitted to the hospital April 26, 1932.

*Roentgenographic examination* (Fig. 6) at this time showed the complete absence of these areas of absorption with union of the head to the neck.

*Physical examination* on May 3, 1932, revealed a complete return of the normal range of motion at the hip.

#### SUMMARY AND CONCLUSION

By traumatizing the epiphyseal line, it is possible to obtain premature ossification in the pre-slipping and mildly slipping cases of adolescent coxa vara, as the splendid results in the three cases reported have shown. The Cotton mallet is used for this purpose.

# CLINICAL AND EXPERIMENTAL OBSERVATIONS WITH REGARD TO THE INJECTION OF CERTAIN AGENTS (PREGL'S SOLUTION) INTO CHRONIC ARTHRITIC JOINTS \*

BY J. E. M. THOMSON, M.D., LINCOLN, NEBRASKA

Chronic arthritis with persistent effusion and thickening of the capsule, whether due to infection or injury, or both, often defies the ordinary methods of treatment and proves disabling. Frequently, patients come with the story of painful swelling of the knee which has been constant for months, perhaps starting with an attack of rheumatism, a fall, or a sprain. The joint has become progressively larger, stiffer, and more disabling.

Certain of these conditions which are due to mechanical derangement of the knee cartilage, ligaments, etc., must be treated surgically for the correction of the derangement; even these cases often present a convalescence associated with chronic swelling of the joint. A small group of chronic infectious arthritis patients are benefited by synovectomy. It is difficult, however, to determine what cases are suitable for this treatment; but, if it could be accurately determined at what stage in the progress of an infectious arthritis the operation is indicated, the results would be gratifying. The operation has a definite field of usefulness, but, as Swett and others have indicated, it is not a panacea.

The results of injections have been uncertain. Occasionally there has been a decided shrinking in the size of the swelling and diminution of the secretion within the knee with relief of these symptoms, particularly when accompanied by accurate treatment of the arthritic process.

Subsequent observations seem to justify the opinion that there is a mechanical or chemical reaction caused by the pathological phenomena of increased synovial secretion that has a retarding effect on the healing process of the arthritic joint. Furthermore, if some substance could be brought in contact with the synovia that would tend to diminish its secretion and shrink the tissue substance within the joint, there would be relief of the symptoms of distention, and of the mechanical irritation of the pathological synovial formations; and, by producing a more normal joint relationship of tissues, a better opportunity would be afforded by immunization, medication, physiotherapy, etc., to render an effective result.

My attention has been directed to Pregl's solution with which, in the clinics of Vienna, rather striking results have been obtained in the treatment of empyema, meningitis, and gonorrhoeal arthritis. This solution appeared first as a secret preparation, described by Pregl in 1919 as a non-irritating, non-staining, watery solution of free and combined iodine with certain iodides. He advocated its use in infections of all kinds, and it has been used by a large number of observers.

\* Presented at the Annual Meeting of the American Orthopaedic Association, Toronto, Canada, June 16, 1932.



A résumé of the recent observations in regard to the therapeutic value of Pregl's solution convinced me that its introduction into the joints would at least do no harm; furthermore, that the antiseptic properties and the astringent qualities exhibited by this iodine solution might prove valuable in treating chronic synovial effusions associated with chronic arthritis.

I had as a patient a doctor who, following an injury on the golf course, sustained a disabling swelling of an old arthritic knee joint. This condition had persisted for several weeks. He was willing to try anything; so with great temerity I drew out some clear, straw-colored fluid from the knee and injected five cubic centimeters of Pregl's solution. The result was indeed commendable. Within twenty-four hours he was better and the effusion remained markedly diminished. After three injections, five to seven days apart, the effusion had entirely disappeared and he started east on a trip. To date he has had no return of his former condition.

With this initial experience, a second case was tried with an equally gratifying result. The effusion seemed to melt away; or, at least, with each injection less effusion resulted, until finally practically normal contour was established in the joint. Unfortunately, no photographs have as yet been taken of any of our patients before or after treatment. Case histories themselves must tell the story. The formula used in the method of preparation of the solution which I use is as follows:\*

To a solution of crystallized sodium carbonate sixteen grams to thirty grams of water, add three grams of finely powdered iodine and allow it to stand for twenty-four hours, rotating frequently, or warm to forty degrees, centigrade, on a water bath. When all the iodine is in solution, add four grams of sodium chloride and water to make one liter.

Bring this to .035-.04 per cent. iodine by gently warming the solution, or part of it, until twenty cubic centimeters is decolorized by .55-.65 cubic centimeters of tenth normal sodium thiosulphate; or until the tint is the same, in equal liquid depth, as that obtained by a mixture of ten drops of tenth normal iodine and fifteen cubic centimeters of water.

The Pregl's solution may be injected into the knee joint, with the patient in the prone or the sitting position. When possible, it is preferable to have the patient sitting with the affected thigh flexed on the abdomen, and the patient's hands clasping the flexed leg on the thigh. This position separates the joint surfaces and places the effusion under considerable tension, thereby making it much easier to remove. It is not at all difficult to insert the aspirating needle into the joint from a point one-half inch internal to the lower patellar tendon, and half an inch above the articulating margin of the tibia. After painting a small area with iodine, two cubic centimeters of one per cent. novocain are used to infiltrate the tissues down to and through the capsules; the aspirating needle is then inserted into the joint with little discomfort and the effusion withdrawn. No effort is made to remove all the synovial fluid. Into a small syringe are drawn five or ten cubic centimeters of Pregl's solution warmed to body temperature. This is injected into the joint, the needle removed, a small dressing applied, and the patient allowed to go about his business as usual.

\* The method described is that which appeared in the *Journal of the American Medical Association*, LXXXI, 1628, 1923.

TABLE I  
SUMMARY OF CASES TREATED WITH PREGL'S SOLUTION

No.	Sex	Age	Occupation	Part Injured	History	Previous Treatment	Fluid Withdrawn	Amount of Pregl's	No.	Result
r. C. 237	M.	40	M.D.	Right knee	Old arthritis, injured by fall and twist, effusion, persistent for four weeks.	Aspiration, hot packs—temporary relief	18 c.c.	5 c.c.	4	Recovered
J. H. 267	F.	30	Dietitian	Right knee	Injury to old arthritic knee, tear of internal semilunar cartilage; chronic synovitis; effusion.	Operation, physiotherapy, vaccines	5 to 30 c.c. clear	5 to 7 c.c.	16	No effusion or acute condition
J. N. 297	M.	30	Line-man	Right knee	Chronic arthritis of long standing. Injury to internal semilunar cartilage. Arthritic changes discovered at operation.	Operation, physiotherapy, rest	Bloody fluid			
					Second operation after Pregl's showed no evidence of previous arthritic condition.		Profuse, not measured	5 c.c.	5	Effusion destroyed; arthritis relieved
J. N. 1320	M.	27	Mechanic	Left knee	Extensive osteo-arthritis and synovitis. Previous operation and cast five years ago. Recent injury to crucial and external semilunar destruction of cartilage apparent at operation.	Operation, brace, physiotherapy, vaccines	15 c.c., of bloody fluid	5 to 7 c.c.	6	No effusion; arthritis arrested
D. H. Orth.	M.	26	Mechanic	Right knee	Internal semilunar injury and operation. Two months later, external cartilage injury. Destructive arthritic changes discovered at second operation. Wound filled with Pregl's solution.	Tried to work after first operation but could not	Bloody fluid, first two aspirations	7 c.c.	4	Recovered
B. 1689	M.	33	Farmer	Left knee	Injury four weeks prior to examination. X-ray negative. Persistent swelling and stiffness, pain.	Packs, rest	Clear fluid	5 c.c.	2	Complete recovery
J. C. M.	M.	29	Laborer	Left knee	Injury five weeks ago. Swelling and stiffness; completely disabled. X-ray negative. Arthritic history.	Iodides, packs, rest, vaccines	10 c.c., clear	5 c.c.	2	Recovered
J. C. F.	F.	56	H.W.	Right knee	Swelling and pain for two weeks, flare-up of old arthritis of knee.	Vaccines	Clear, straw	5 c.c.	2	Recovered
D. E. C. C. F.	F.	14	Child	Both knees	Effusion of both knees for two months, worse on right. No pain; some stiffness. All tests negative.	Vaccines	20 c.c., clear fluid, right	8 c.c.	5	Very much improved
K. 1787	F.	53	H.W.	Right knee	Chronic arthritis with effusion.	Vaccines	10 c.c., clear	5 c.c.	2	Recovered
J. 1788	M.	49	Mechanic	Right ankle	Acute pain and swelling following accident, few days previous. Fluctuation, redness. Temp. 101; W.B.C. 14500.		7 c.c., purulent	5 c.c.	1	Recovered
J. B. C. M.	M.	35	Laborer	Bursitis of elbow	Olecranon bursa—two weeks.		3 c.c., clear	3 c.c.	1	Recovered
J. G. C. C. M.	M.	20	Student	Left ankle	Gonorrhoeal arthritis of ankle—three weeks.	Vaccines	Purulent fluid	5 c.c.	1	Improved
Mrs. B. F.	F.	58	H.W.	Prepatellar bursitis	Bursitis from scrubbing.		Bloody	4 c.c.	1	Improved

No reaction has been noted either of a general or local type. Sometimes a patient will complain of pain and discomfort for the first few hours; after that considerable relief is expressed uniformly. In five to seven days this procedure is repeated, and usually two to five injections are sufficient to stop the effusion and relieve the symptoms.

Thirteen cases are summarized in the table. The synovial fluid withdrawn in each instance was cultured, and no growth occurred in a single instance. The following brief survey of two cases is illustrative of the uniform results obtained in the series summarized. The first case is one in which arthritis is complicated by injury; the second is of undetermined etiology.

CASE 1. (No. 0267.) Miss H., female, aged thirty, dietitian by occupation, had had an old arthritis in the right knee for many years. She slipped on the dance floor of the club in which she was employed, severely injuring the knee. She had all the symptoms of injury to the internal semilunar cartilage. On June 16, 1931, operation was performed. The cartilage was removed and was of the "bucket-handle" type. There was a destructive change in the cartilage surface of the condyles, and a generalized synovial pannus. Exploration of the outer side of the knee showed no evidence of injury to the external cartilage, but a similar arthritic process existed. She had an uneventful convalescence from the operation, and the wound healed by first intention. She continued to have swelling and profound disability and inability to use the knee. After four and a half months of physiotherapy and treatment of the arthritis, on October 3, 1931, twenty cubic centimeters of clear, straw-colored fluid were withdrawn from the knee, and five cubic centimeters of Pregl's solution were injected. Injections were continued at irregular intervals until April 18, 1932, there being sixteen injections in all. We were unable to



FIG. 1

Rabbit No. L. Knee Joint No. 21 treated with Pregl's solution shows much less hypertrophy of the synovia and pannus than the untreated Knee Joint No. 29. There was considerable erosion of the cartilage in Knee Joint No. 29, whereas cartilage of No. 21 was smooth.

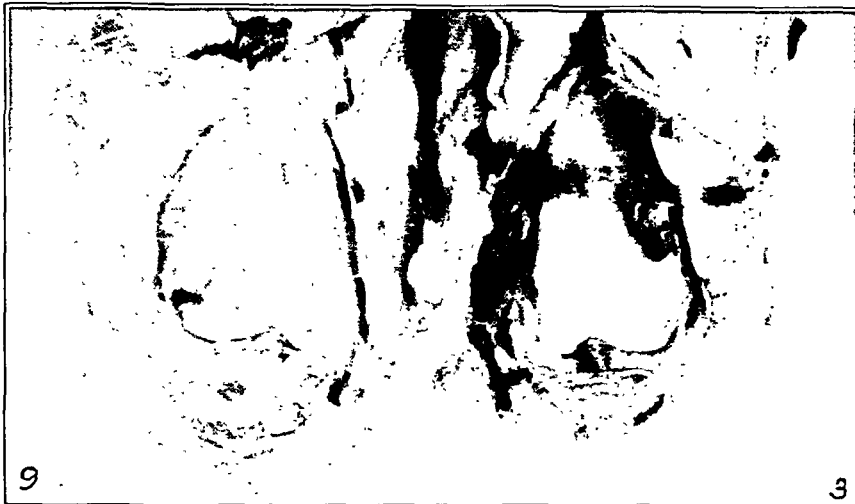


FIG. 2

Rabbit No. N. Note the marked difference in the synovia and cartilage edges between Knee Joint No. 9, which was treated with Pregl's solution, and Knee Joint No. 3, in which no treatment was administered. No. 3 was extremely red, thickened, with extension of synovia over the femur with adhesions on the inner aspect, frayed margins, and destruction of the cartilage along the edges of the condyle as well as of the patella; while No. 9 had a clean, bright, normal-appearing synovia and the cartilage injury was apparently healing.

withdraw any fluid at the occasion of the seventh injection. Function of the knee is very markedly improved, and she has a range of motion to eighty per cent. The knee is still quite thickened, but, as the knee has been enlarged for two or three years, it is a little difficult to tell how much shrinkage will result. Two months after the operation she resumed her duties, although she wore a brace until about four months ago. The effusion has entirely disappeared: she is much improved, and has no pain or discomfort in the knee. This has been by far the most serious case I have treated, and one which showed absolutely no progress until injections of Pregl's solution were started. She has received no treatment since the first part of April. Prior to that time she had come in occasionally and desired another injection of Pregl's solution as it seemed to give a certain amount of relief of discomfort in the knee. In this case, under ordinary circumstances, I would have performed a synovectomy, but she would not consent to an operative procedure.

CASE 2. Dorothy E. (City Clinic), female, aged fourteen. For six months she had had persistent swelling in both knees, the right more severe than the left. She was left with some stiffness and swelling together with pain. All tests for tuberculosis, syphilis, and gonococcus were negative. Cultures from the effusion were negative. She was under observation for three or four months. About six weeks ago twenty-four cubic centimeters of clear, straw-colored fluid were drawn from the right knee and seven cubic centimeters of Pregl's solution were injected. After five injections the right knee had assumed nearly normal appearance and the swelling of the left knee had remained constant. Crowe's stock vaccine was given during this period, rather empirically. Two weeks ago the left knee was aspirated and injected with Pregl's solution, and improvement was evident at the time of the second injection. Although one of our more recent cases, she has proved most interesting in that a similar condition existed in both knees with a chronic effusion that had lasted over six months. An accurate diagnosis has not been made; but, until this treatment was instituted, the condition had become progressively worse. The right knee, which was the more severely affected, was treated for five weeks with the result that it had assumed almost normal appearance, while the left knee

remained constant. Now the Pregl's solution has been injected into the left knee, with the result that the effusion has disappeared. Both knees have assumed normal contour and appearance, and the patient now has no discomfort or disability.

The clinical manifestation of the value of Pregl's solution in the first few cases of chronic synovitis, or effusion associated with trauma and arthritis, led me to attempt an experimental study to determine the effect of the solution on the joints of rabbits affected with similar pathological conditions. This work was started in November 1931, and carried out in the experimental laboratory of the Lincoln General Hospital with the assistance of Dr. Fritz Teal, and Miss Mildred Wieland. We endeavored to follow the methods of stimulating arthritis and synovitis developed by Key and others. Our space was limited and few animals could be worked with at a time; therefore, we have not progressed very far with this problem. To date sixteen rabbits have been used, but, in order to carry out the project accurately, only four were brought to a sufficient culmination to allow a report of the results obtained.



FIG. 3

Rabbit No. P. Knee Joint No. 42 was treated with Pregl's solution, four injections, while Knee Joint No. 48 was untreated. Cartilage of both joints was extensively destroyed before treatment was started. Knee Joint No. 42 into which the Pregl's solution was injected showed grossly marked healing of the diseased synovia; however there was but little healing of the cartilage; while the synovia of knee joint No. 48, which was untreated, was very much thickened, red, and infected, and was filled with a purulent exudate.

Arthritis was produced by two methods, first, by introducing infection into the joint directly; second, by introduction of one-half of a cubic centimeter of one per cent. carbolic solution and one-half strength tincture of iodine. In most instances a period of two to four weeks elapsed between the operative intervention and the beginning of treatment. All operations were carried out under strictly aseptic conditions. On account of the fact that we wanted exactly similar conditions in both knee joints of the same rabbit, an exploratory arthrotomy was performed before treatment was instituted, in order to determine whether the condition of both joints was similar. Then one joint was treated with Pregl's solution and the other allowed to heal without treatment. So far only gross specimens have been studied.

In adult rabbit No. L., streptococcus was introduced into both knee joints. Two weeks later the arthrotomy was performed and there was found a profound pannus and increase in synovia with changes about the joint surfaces of the condyles. Both knees appeared relatively the same. The rear extremities of the rabbit were numbered 21 and 29. The knee joint of No. 21 was injected with one and one-half cubic centimeters of Pregl's solution three days following the arthrotomy. Every three or four days thereafter a similar amount of Pregl's

solution was introduced. At the end of four weeks the rabbit developed a respiratory infection and was sacrificed. There was marked synovial change and the knee joint cartilages of both looked slightly eroded. However, knee joint No. 21 (treated with Pregl's) showed much less hypertrophy and pannus of the synovia; the joint had margins which looked almost normal, but there was some cartilage erosion of the condyles similar to No. 29.

No. N., a young rabbit fourteen weeks old, had an arthrotomy in which extremity No. 3 had the synovia scraped and injured about the margins of the joint. In the knee of extremity No. 9 a section was taken out of the external condyle and the synovial edges about the joint were scraped. Two weeks later arthrotomy was again performed. Both joints seemed extremely red, swollen, and inflamed. Profound pannus existed throughout the joints with marked increase of synovial fluid. The knee joint of No. 9 was treated with Pregl's solution every three to five days for three weeks. The rabbit was then sacrificed. There was quite evident difference between the synovia of the treated and untreated joints. The knee joint of No. 3, showed a redness, thickening, and extension of synovia over the femur with adhesions about the inner aspect of the knee. However, the knee joint of No. 9 had a smooth, clean synovia similar to a normal rabbit's knee joint. The cartilage appeared to be healing, but with considerable thickening at the border.

Rabbit No. P. was a young rabbit fourteen weeks old. Both knee joints were injected with a culture of staphylococcus albus. Two weeks after injection was administered, both joints were extremely swollen and fluctuating. Effort was made to remove the effusion by needle, but the material could not be withdrawn. Exploratory arthrotomy was performed in this instance and the thick seropurulent fluid withdrawn. Knee joint of No. 42 was treated with Pregl's solution every three to five days, while the knee joint of No. 48 was untreated. Thereafter the rabbit developed a generalized infection, and died three weeks after treatment was started. Although the cartilage of the femoral articulation of both joints was largely destroyed, there was considerable pannus thickening of the synovia about the margins of the knee joint of No. 48. The synovia of the knee joint of No. 42 was in no wise thickened, although it did give evidence of an extensive diseased process.

Rabbit No. K. had an arthrotomy of both knees with injury to the external condyle. The knees were washed with ten per cent. carbolic acid and iodine. However, the knee of extremity No. 60 was washed and filled with Pregl's solution prior to closing the wound. No. 62 was simply closed after the carbolic and iodine had been applied in the joint. Immediate treatment was started on extremity No. 60 and was continued at intervals of from three to five days for six weeks. The result was quite striking. The knee into which the Pregl's solution was injected after the injury and chemical trauma was practically normal, but the knee which was not treated showed extensive loss of cartilage.

Admittedly there are several sources of error in such experimental work. Microscopic sections have not been run in any of these joints.

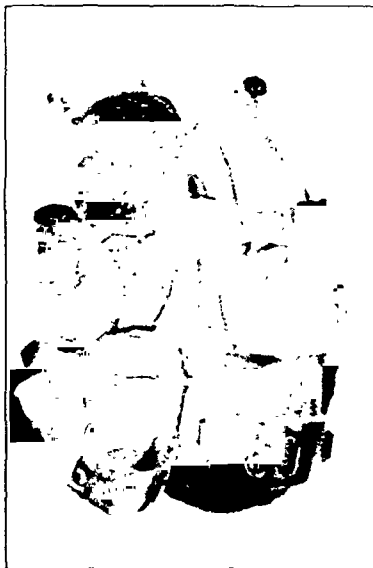


FIG. 4

Rabbit No. K. Knee Joint No. 60, after treatment with Pregl's solution appeared practically normal, while Knee Joint No. 62, which was untreated, showed considerable loss of cartilage and synovial thickening.

Nevertheless, there seems to be something in the use of Pregl's solution that quite definitely affects the synovia, even in the presence of severe infection, to the extent that it apparently produces an inactivity or diminution of synovial secretion with an atrophy or shrinking of the synovia, very definitely inhibiting an infectious process and perhaps promoting cartilage regeneration. Of course this experimental data is in no wise conclusive, and the clinical material represents but a small group of cases; nevertheless, the similarity in results between the clinical cases and the experimental animals seems to warrant further investigation and a more general use of Pregl's solution in treating chronic effusion of arthritic and traumatized joints.

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## METASTATIC INFECTION OF BONE AND JOINTS AS THE INITIAL CLINICAL MANIFESTATION OF GASTRIC NEOPLASMS \*

BY HARRY A. SINGER, M.D., AND L. WILLARD SHABAT, M.D., CHICAGO, ILLINOIS

When the source of a suppurative process in a bone or joint is sought, a lesion of the gastro-intestinal tract is seldom if ever included in the list of possibilities. Particularly is this the case if symptoms referable to the digestive system are lacking. That the primary focus of a bone or joint infection may be located in the stomach, for instance, is borne out by our experience with three patients. The first, seen clinically by one of us (H. A. S.), suffered from a suppurative osteo-arthritis of the knee. The primary site was not suspected or discovered until autopsy, when an ulcerating, infected leiomyoma of the stomach was disclosed. This case has been reported in detail, chiefly from the anatomical standpoint, by Wells.<sup>1</sup> Each of the two other patients entered the Hospital on account of a suppurative osteomyelitis. In each an ulcerated, infected, gastric carcinoma was found and no other source to explain the metastatic purulent process.

Because of the clinical significance of this group of cases, the individual examples appear to warrant more than mere mention. The details in connection with the case of leiomyoma are recorded elsewhere by Wells.<sup>1</sup> The essentials relative to the two cases of carcinoma are as follows:

CASE 1. G. H., a white man of fifty-four, entered the Cook County Hospital on June 10, 1929, complaining of "rheumatic" pains. His case was diagnosed as a subacute polyarthritis of the rheumatic type and he was given salicylates for a few days and then discharged. On October 23, 1929, he reentered the Hospital, complaining of irregular chills, fever, and profuse sweats which he had noted for a month. Although he suffered a recurrence of his joint pains shortly after his discharge in June, he experienced no severe pain until a few days prior to his present admission, when his back and right shoulder became quite painful. The patient was a sailor by occupation and had been in the tropics several times. He recalled an illness at the age of thirty-two which was diagnosed as malaria. Malarial parasites, however, were not demonstrable in the blood; and quinin failed to exercise any salutary effect.

A suppurative process was assumed, but a search for the location of the pus proved futile. X-ray examination of the joints and of the dorsal spine made shortly after admission was reported negative. A liver abscess was suspected, but neither an etiology nor physical evidence of such a lesion could be established. The patient slowly sank and died December 10, 1929. The autopsy, which was performed by Dr. R. H. Jaffé, disclosed an osteomyelitis involving the fourth and fifth lumbar vertebrae and bilateral psoas abscesses. On the greater curvature of the stomach, in the mid-portion, was a large, fungating, ulcerating, medullary carcinoma which was presumed to be the source of the bone infection. No tumor metastases were found. A relatively recent abscess in the left lower pulmonary lobe which led to an empyema had precipitated the termination.

\* From the Department of Medicine, University of Illinois College of Medicine and the Cook County Hospital.



CASE 2\*. J. W., a white man of fifty-two, entered the Cook County Hospital for the first time on March 14, 1929, with complaints ascribed to a suspected gastrojejunal ulcer. This diagnosis was based on the presence of what were interpreted to be ulcer symptoms and also on the history of a pylorotomy, with a posterior gastro-enterostomy, performed in 1918. He was placed on Sippy management for ulcer and appeared to improve satisfactorily. He was discharged on April 1, 1929, and immediately returned to his usual occupation.

The patient continued to work until October 5, 1929, when, while stooping, he experienced a sudden pain in the lower dorsal region which prevented him from straightening. Since the pain maintained its severity, on October 7, two days following the onset of the illness, the patient reentered the Hospital. Roentgenograms of the lower thoracic and dorsal spines taken at the time of admission were reported negative. The temperature varied between 100 and 102 degrees. Within a relatively short period a fluctuant swelling could be detected in the upper lumbar region. Aspiration with the aid of a needle and syringe yielded pus. X-ray examination at this time disclosed a destructive process involving the twelfth dorsal and first lumbar vertebrae, diagnosed as osteomyelitis. The abscess overlying the bone was incised and drained, after which decided improvement followed. Ten days after operation the temperature had returned to normal and no noteworthy pain was felt in the back.

After recovering from the osteomyelitis the patient made reference to mild gastro-intestinal symptoms. On investigation an egg-sized mass was palpated, and in the roentgenogram a filling defect in the region of the gastrojejunal stoma, interpreted as carcinoma, was disclosed. Because of the patient's refusal to submit, operation on the stomach was delayed until February 6, 1930. At laparotomy undertaken at this time, a polypoid mass encircling the gastrojejunal stoma was found and resected. There were no metastatic deposits encountered. The patient died two days after operation from a gastric hemorrhage. Permission for autopsy was refused.

The surgical specimen showed the tumor to be made up of numerous polypoid growths which projected like villi from the gastrojejunal margin into the lumen. Many of the polyps were covered with fibrin, but gross evidence of suppuration was not observed. In studying the microscopic sections, however, a dense polymorphonuclear infiltration was found in many areas, scattered among which were numerous microorganisms. The infection of the growth was assumed to be the origin of the metastatic, suppurative spondylitis. The histological diagnosis of the tumor was adenocarcinoma.

#### SUMMARY AND COMMENT

We have observed three instances in which suppurative lesions of bone and joints had their origin in silent or relatively silent gastric neoplasms. In one, reported by Wells,<sup>1</sup> purulent arthritis of the knee was traced to an infected leiomyoma of the stomach. In a second patient, the only symptoms present during life were referable to an osteomyelitis of the spine. The primary focus discovered at autopsy was an ulcerated gastric carcinoma. The third patient entered the Hospital also on account of a purulent spondylitis. The infected carcinoma which constituted the source of the bone involvement had not caused sufficient discomfort to lead the patient to seek medical advice prior to the onset of the septic complication.

The observation that a metastatic lesion of a bone or joint may be the initial manifestation of a gastric tumor is of more than theoretical interest. From the practical standpoint it is of significance to know that, in a pa-

\*For a detailed report of this case from the gastro-intestinal standpoint, see Singer<sup>2</sup>.

tient of cancer age, an osteomyelitis or suppurative arthritis of obscure origin may be due to an ulcerating growth in the digestive tract. Since the stomach is the most common site of primary carcinoma, a search for a gastric malignancy is warranted under these circumstances.

It is, furthermore, important from the practical side to note that carcinomata which are prone to lead to metastatic infection are generally fungating and polypoid. This type of tumor tends to grow into the gastric lumen rather than along or beyond the walls, a circumstance which permits extirpation and favors permanent cure. In all three cases referred to, a knowledge on the part of the attending physicians and surgeons of the factors involved would have rendered the ultimate outlook more hopeful.

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# A CASE OF PROGRESSIVE ATROPHY OF THE FACIAL BONES WITH COMPLETE ATROPHY OF THE MANDIBLE

BY K. H. THOMA, D.M.D., BOSTON, MASSACHUSETTS

*Professor of Oral Pathology, Harvard Dental School  
Oral Surgeon, Brooks Hospital, Boston*

This case is reported because, as far as can be ascertained, it is the only case on record of complete atrophy of a bone, and because its etiology presents probably an unanswerable question. The case was referred to the author for study by Dr. R. H. Norton.

Only one case approaching it could be found in the literature,—that of Absorption of the Humerus after Fracture.<sup>1</sup> The patient fractured the humerus three times, after which the bone slowly and painlessly disappeared. The skin of the arm was never broken and no bone came out. The specimen from autopsy (patient died at age of seventy) was dissected by Prof. T. Dwight, and is now at the Warren Museum. The roentgenogram of this specimen taken by Dr. Sosman shows three thin spicules of bone, the only part of the humerus remaining.

## CASE REPORT

Mrs. M. S., aged thirty-six, housewife.

*Family History:* There was no family history of cancer, tuberculosis, diabetes, gout, rheumatism, arthritis, kidney disease, hemophilia, anomalies in size, epilepsy, insanity, or venereal disease. The father died of heart trouble at thirty-five; there was no other history of heart trouble in the family. One sister had a goiter and was said to be nervous.

*Marital History:* Patient had been married sixteen years. Husband was living, as were three children; the oldest, son of fifteen, had enlarged glands in neck and hay fever; the second, boy of twelve, and third, boy of six, were well. Patient had had no miscarriages. Her teeth ached quite a little with the first baby and less with the second.



FIG. 1

Dental film taken August, 1924. No evidence of pyorrhea or alveolar resorption.

*Past History:* Pertussis and measles in childhood; occasional "grippe" and the influenza during the great epidemic. Eight years before patient had had her upper teeth removed because of abscesses (Fig. 1). Two months later she noticed teeth of lower jaw loosening so that if one was moved all the teeth moved with it. A week later she had these lower teeth removed. She suffered pain in mandible and had pus drain from it. The following year, after jaw had completely healed, she had dentures made.

These were satisfactory and jaws gave her no more trouble until present illness.

*Present Illness:* Patient, when five months pregnant, felt a dull ache in the right mandible, which continued until August of that year, when her baby, then three months old, hit her in the right side of jaw at various times. Each time this caused severe pain and a "grating feeling". For this condition she went to a hospital in Maine, where roentgenograms were taken, which showed extreme atrophy of mandible with fracture on

the right side (Fig. 2). Treatment was symptomatic. She returned home and suffered pathological fracture on left side of mandible from merely swallowing while in bed. She suffered a great deal of pain and returned to the hospital, where further x-ray studies were made. She was referred by a friend to the Massachusetts Memorial Hospital in Boston. A roentgenographic examination made at that time showed "thin detached sequestrum of anterior and lateral portions of lower jaw". She was relieved by alcohol injections and was discharged.

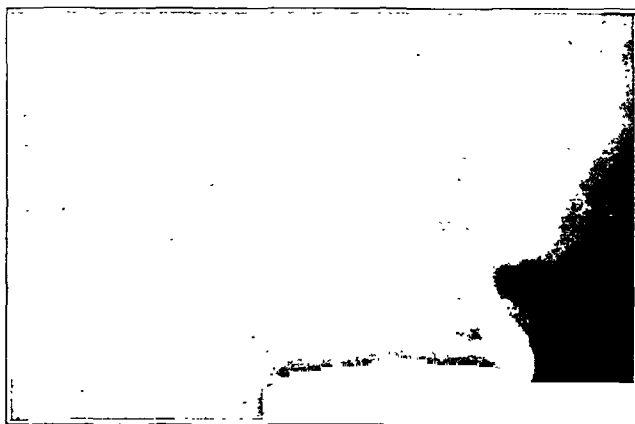


FIG. 2

Roentgenogram of mandible taken August 31, 1926, showing bone atrophy and fracture.

When the writer examined the above roentgenogram recently, it occurred to him that it had been overexposed, and he had the photographer reduce it. The finer detail of the plate then became visible (Fig. 3). From this picture it appeared that at that time the anterior part of the mandible had become atrophied and had been bent down by the flexor muscles at the place of the former fracture. This was later borne out when the two roentgenograms (Fig. 2) were received from the hospital in Maine (courtesy of Dr. F. B. Ames). The piece of bone, in the opinion of the writer, was not a sequestrum, but rather a broken fragment of live bone.

During the following thirteen months patient showed little improvement. She was readmitted to the hospital and after symptomatic treatment she was transferred to the Evans Memorial Hospital for more study. Her physical examination was normal save that she was under weight (seventy-eight pounds). X-ray examination showed all bones of skeleton normal, except the mandible; resorption of the entire mandible, including rami and condyle of the mandibular joints, had occurred (Fig. 4). At home she kept house, worked hard, and lost a little weight. Her jaw



FIG. 3

Roentgenogram of mandible taken October 1, 1926, showing anterior fragment of mandible pulled down by muscles. Note enlarged mandibular canal.

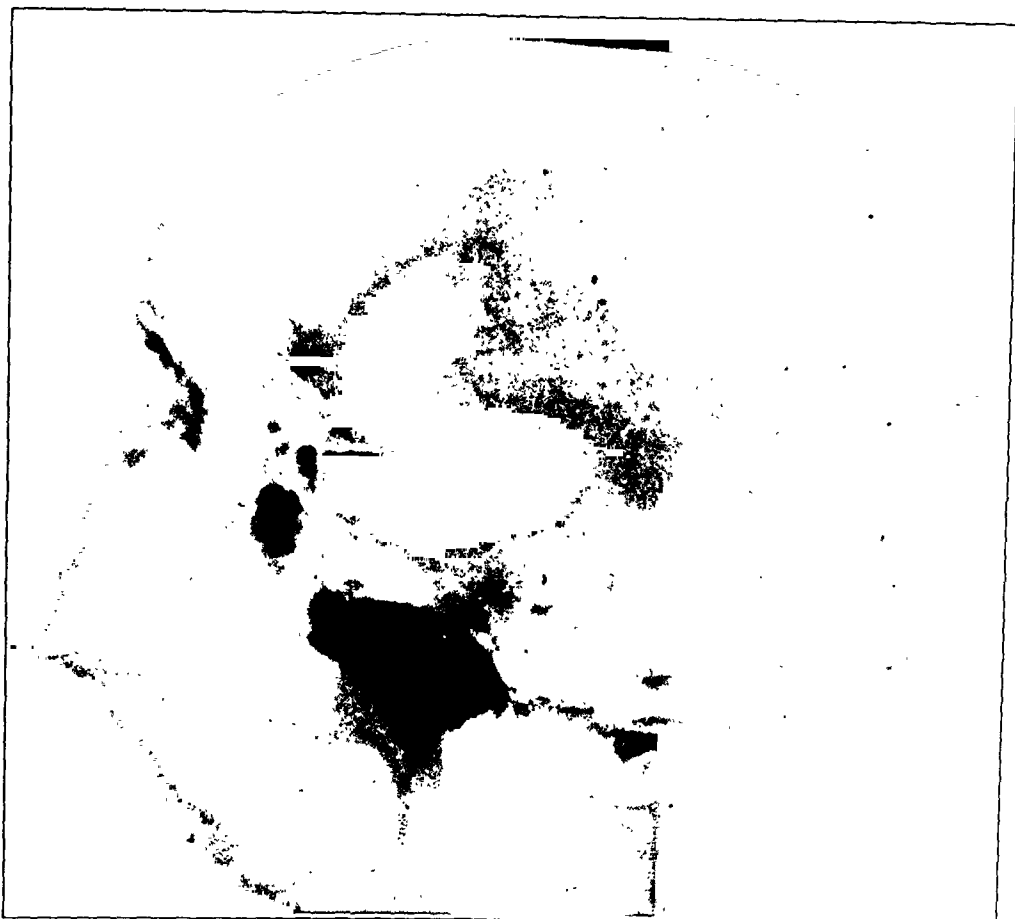


FIG. 4

Roentgenogram of skull taken April 30, 1928. Calvarium normal. Sella turcica normal. Mandible completely absent; maxilla normal except for atrophy of alveolar process, a condition normal after extraction of all the teeth.



FIG. 5

Appearance of face, April, 1932, showing normal position of chin.



FIG. 6

Appearance of face, April, 1932, showing how chin can be pressed to pharyngeal wall.

ached only at times. After wearing dentures for a while, she ate (without her teeth) a deficient diet of meat, potato, white bread, and canned vegetables. She liked butter; ate practically no eggs; drank coffee, but no milk.

In April, 1932, she was examined by the writer at his office. She then appeared as a very thin woman, in no obvious distress. Facial expression was unusual, due to marked retrusion of lower jaw (Fig. 5). Chin could be pushed to pharynx without pain (Fig. 6).

*Physical Examination* at the Evans Memorial Hospital showed a not too well developed white woman of thirty-six years. A slight exophthalmos was present. What appeared to be thin layers of adipose tissue beneath the bulbar conjunctivae were encroaching toward the cornea from both inner and outer angles of both eyes. Hearing was normal; no discharge or mastoid tenderness. There was no discharge or obstruction of nose. Tonsils were small and not inflamed. There was a slight enlargement of the thyroid on the right and a few large anterior cervical lymph glands.

Four years before, over the left lower lung posteriorly, there was slightly increased tactile fremitus, considerable increase in vocal fremitus, very slight comparative dullness and fine moist râles on deep inspiration only. There was no friction rub, and the lungs were otherwise normal. In 1932 all signs were normal.

Heart sounds were regular and of good quality, with no murmurs, thrills, or evidence of enlargement. The abdomen was normal. Kidneys and spleen were not palpable; the liver was not enlarged. The skin was normal. No axillary or inguinal glands were found. Two glands smaller than peas could be palpated in the left anterior cervical chain; they were not tender. No bowing of long bones; epiphyses normal; hands, fingers and nails normal. No oedema or cyanosis.

*Neurological Examination:* Sensory response to light, touch, sharp and dull points, heat and cold were normal, with possible exception of distribution of trigeminus, where there was questionable decrease in sensation of conjunctiva of left eye. Cranial nerves were otherwise intact, save possibly the auditory (eighth cranial) as evidenced by poor station with slightly

increased swaying. Coordination was normal except on left forefinger-to-nose test, which shows pass-pointing by two centimeters on repeated trials (1928). No tenderness over nerve trunks or demonstrable disturbance of sensation. No tremors, atrophies, or palsies. Train and content of thought normal. Reflexes normal, active and equal.

*Laboratory Examination* (Evans Memorial Hospital):

Urine: Normal on repeated examinations.



FIG. 7

Roentgenogram of jaws taken April 25, 1932. Mandible completely resorbed. There is evidence of atrophy of tuberosity of maxilla, palatine bone, and internal pterygoid plates and hamular process of sphenoid.



FIG. 8

Biopsy from premolar region in left maxilla where roentgenogram showed active resorption. ( $\times 36$ .)

Later showed slight trace of albumen, but never any casts or other pathology. Blood: Normal morphology and blood chemistry (non-protein nitrogen, urea nitrogen, uric acid, creatinin, phosphorus, and calcium). Sugar was 108 to 125 milligrams per hundred cubic centimeters of blood, but down to eighty-seven milligrams per hundred cubic centimeters of blood later. Cholesterol was 286 milligrams per hundred cubic centimeters of blood.

Wassermann and Kahn were both negative on repeated tests. Sputum, negative. Spinal fluid, negative. Renal function, normal (phenolsulphonaphthalein test). Liver function, normal (galactose tolerance low; ten to twenty grams to less than ten grams). Basal metabolism, low (minus twenty per cent., Boothby-Sandford standard). Vital capacity, low (minus twenty-one per cent., Dreyer).

*Roentgenographic Examination:* (Dr. A. W. George and Dr. R. D. Leonard). At this

time, x-ray showed bones of entire skeleton normal, save skull. No evidence of osteomalacia or generalized osteitis fibrosa. The mandible was completely resorbed; the maxilla showed resorption of the alveolar process in the posterior part. Tuberosity was resorbed with the pterygoid plate and pterygoid hamulus of sphenoid. Only the cortical bone of the maxillary sinus remained. In the anterior part was evidence of resorption of the alveolar process (Fig. 7). (See Figure 4 taken four years before.)

*Pathological Examination:* In discussing this case Dr. Ludwig Pick of Berlin, who was visiting Harvard, expressed the opinion that the patient's condition must be due to a "brown tumor of von Recklinghausen's disease" and that biopsy of an affected part would prove his contention.

*Operation:* Under local anaesthesia, a vertical incision was made in the premolar region of the left maxilla. Apparently the bone had resorbed, for the knife passed upward without resistance for one and one-half centimeters (it usually strikes bone at about one-quarter centimeter). Bone was then cut with saw. In removing a small section with chisel, bone became loosened from the soft tissue and the two were removed together, a mass about one and three-quarters centimeters in diameter. The wound was closed with sutures and healed uneventfully.

*Microscopic Examination:* (Dr. G. A. Bennett, Department of Pathology, Harvard Medical School). "The largest tissue fragment (Fig. 8) is bounded on two sides by stratified epithelium, which shows numerous long, narrow papillae extending into the sub-epithelial tissue. Beneath the epithelium is a thick layer of connective tissue, which is peculiarly divided into small subdivisions by blood vessels and capillaries. The connective-tissue bundles, while not very dense in texture, do not contain many nuclei. Many more nuclei, together with a scattering of plasma cells and mononuclear large cells,

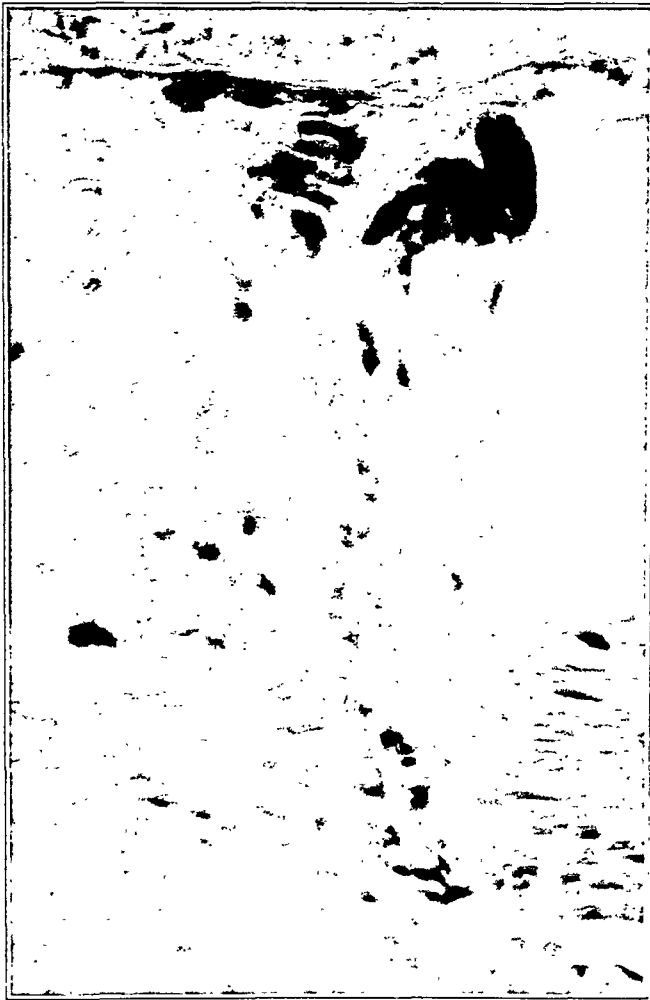


FIG. 9

Biopsy showing large vascular space in trabeculae. ( $\times 700$ .)



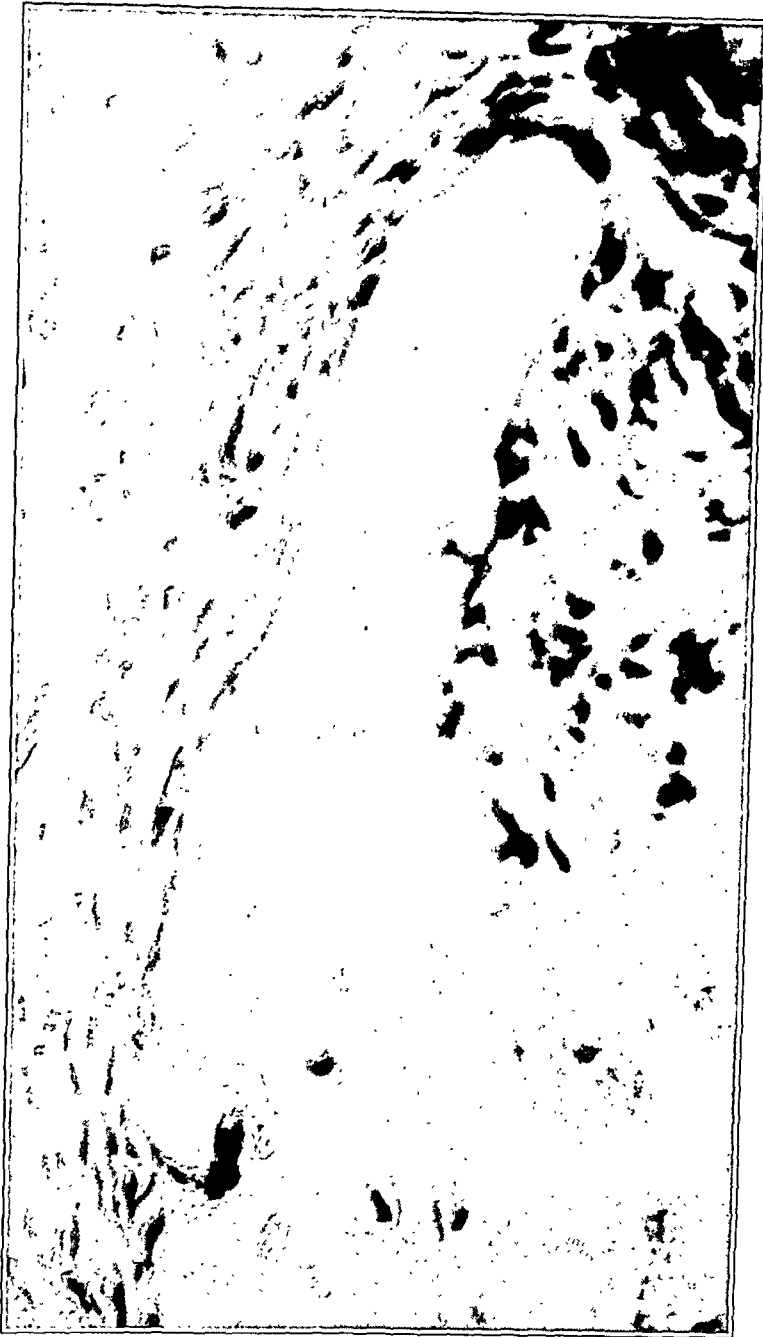


FIG. 10  
Biopsy showing trabeculae. ( $\times 700$ .)

are present around capillaries. In the deepest portion of this section are found a number of bone fragments. The bone changes seen in these are essentially the same. In the light of the history of this case, they are difficult to interpret. Some degree of porosis or atrophy is indicated by the relative amounts of bone trabeculae and marrow tissue and by the relatively large, vascular spaces in the bone trabeculae (Fig. 9). Evidence of resorption of bone is almost entirely lacking, although there are slight notching and marginal irregularities in a few of the trabeculae (Fig. 10). On the other hand, there is evidence of feeble apposition of osteoid in scattered areas. In such instances a layer of osteoblastic cells overlies the osteoid deposit. On the whole, the marrow tissue is fatty. There are, however, a few areas in which it appears that a condensation of marrow blood vessels and fibrous tissue has occurred. Such a con-

densation may be due to atrophy of bone trabeculae. An adequate diagnosis from the histology of this tissue is not possible; hence, it will be cataloged under the diagnosis of 'Bone Atrophy'. There is no evidence of any inflammatory processes or generalized osteitis fibrosa (hyperparathyroidism)."

*Blood Calcium:* Blood calcium study was made at this time by Dr. J. C. Aub and found to be within normal limits (serum calcium, eleven and two-tenths milligrams; serum phosphorus, three and six-tenths milligrams; no phosphatase run). Wassermann and Kahn reactions were negative. Patient has never had any contact with phosphorus lead, arsenic, radium, or mercury.

*Diagnosis:* Progressive atrophy of the jaws; complete atrophy of mandible.

*Subsequent Course:* Patient was prescribed a more balanced diet, relatively rich in

calcium, phosphorus, and vitamins (dairy products) and was given in addition viosterol and cod liver oil. This she followed faithfully and, when seen two months later, she showed considerable gain in weight and well-being. When again admitted to the Evans Memorial Hospital, three months later, she stated that she felt well during the summer, worked hard at household duties and canning fruit. She kept strictly to the diet prescribed, but had to eat without her artificial teeth. She again had lost some weight. Late in summer, she suffered a head cold; at least, there was discharge from her nose. Also pains came back; aching and throbbing and constant pains were felt, especially running across the right cheek and radiating to the temporal region and to the ear.

*Roentgenographic Study:* Further resorption of the maxilla had occurred. The posterior wall of the maxillary sinus had been completely resorbed, but the calvarium, chest, and long bones were still entirely normal.

The disease no doubt was initiated by dental infection. This infection, however, was completely cleared up by extraction of the teeth and subsequent treatment. During a long interval, the jaw was normal and dentures were worn with comfort. At the end of her third pregnancy, pain started to appear in her jaws, which was the first indication of the disease. The pathological process at that time apparently caused fragility of the bone, which predisposed to pathological fracture from such a trivial cause as a blow from the fist of an infant.

The roentgenogram, taken at that time, showed progressive atrophy of the mandible beyond the ordinary atrophy seen after extraction of all the teeth. The one important feature in the early roentgenographic picture was an abnormally large mandibular canal (Fig. 3). There was no evidence of infection in the bone at that time. In twenty months the mandible was completely resorbed, leaving a flexible membrane in the place of the jaw.

During the four years following, the disease progressed further, involving various parts of the maxillary, palatine, and sphenoid bones. The few facts which can be summarized are:

1. The disease is progressive.
2. It involves the bones in the distribution of the fifth cranial (trigeminal) nerve; no evidence of hyperparathyroidism.
3. There persists a certain amount of pain in the distribution of this nerve.
4. All other bones are normal.
5. With increased calcium and vitamins in the diet, patient has for a time been gaining weight, but bone condition has been getting progressively worse.
6. The involvement of bones in the distribution of the fifth cranial nerve and its ganglia, and the persistent pain connected with the bone resorption, suggest classification of the disease as neurotrophic atrophy.

## DOES A SUCCESSFUL FUSION OF THE TUBERCULOUS HIP CURE THE TUBERCULOUS PROCESS?

BY C. F. EIKENBARY, M.D., AND JOHN F. LECOCQ, M.D., SEATTLE,  
WASHINGTON

Within recent years many surgeons, following the lead of the late Dr. Russell Hibbs, have taken the attitude that all tuberculous hips should be fused, and that a successful fusion ended the infection. Within certain bounds, we have been, and still are, in accord with that view. Without wishing, at this time, to go into the details as to treatment, we might state that we feel that where destruction has not actually taken place, the conservative treatment—prolonged traction and sunshine, etc.—has a definite place. We also feel that fusion should not be done in children before the age of six or seven, owing to the lack of bony development requisite

to a successful fusion. The following case, with autopsy findings, is presented in the hope that it may make a slight contribution to our knowledge of the above problem.



FIG. 1

Roentgenographic appearance one year after fusion.



FIG. 2

Photograph of hip at autopsy.



FIG. 3

Transverse section of hip and portion of ilium. Solid, bony fusion. Tuberculous area still present.

H. E., aged eleven, was admitted to the Children's Orthopaedic Hospital May 22, 1928, with a diagnosis of tuberculosis of the hip. Conservative treatment was tried and failed. Fusion operation was performed on March 18, 1929. Guinea-pig inoculation, following the fusion, established the diagnosis of tuberculosis of the hip. The boy made an uneventful recovery and was discharged from the hospital a little over a year later, cured, as shown by clinical and roentgenographic examination. For a period of a little over two years, the boy was perfectly well, the hip being solidly fused. There was no pain, and the boy led the usual active life. He could run up and down stairs without difficulty and had only a slight limp. We considered the result to be extraordinarily good.

Two years after we had dismissed him as cured, the boy was readmitted to the hospital with the clinical symptoms of tuberculous meningitis. He died two weeks later and the autopsy findings were quite typical of tuberculous meningitis. The upper end of the femur and a portion of the ilium were removed for examination purposes. The photograph of the hip, together with roentgenograms made after removal, are herewith presented. A solid bony fusion was evident, but in the upper end of the femur and in the remnant of the neck, there were present several typical tuberculous areas. This was confirmed by microscopic examination.

Comment is probably unnecessary. Certainly the findings prove quite clearly that a successful fusion does not necessarily end the tuberculous process. However, we feel that the above case must be most unusual, and the final result does not materially detract from the value of the operation.

# CONGENITAL ANOMALY OF THE LEFT FEMUR

BY JULIUS S. NEVIASER, M.D., WASHINGTON, D. C.

Congenital anomalies of the femur are very uncommon, and this case is reported because a review of the literature does not reveal a similar condition. Again, it is of extreme importance that every case of rare congenital deformity coming under the care of the surgeon should be reported, as it may be helpful in further investigations both of an embryological and an anatomical nature. The questions as to whether syphilis plays any part in the etiology, and what form of treatment could be used in this case, are both interesting problems.

## CASE REPORT

R. A., female, aged twenty months, was born with a short left leg. This was the first child, pregnancy and labor being without difficulty. The parents have positive Wassermann tests, although the child's Wassermann test was negative. The second child, recently born, is apparently normal in all respects.



FIG. 1

The child started to walk at the age of nineteen months.

*Physical Examination:* White female, well nourished for her age. Except for the left lower extremity which is much shorter than the right, the examination was negative. In the recumbent position the child held the left lower extremity in the frog position. Upon standing on the right leg, the left was held in ninety degrees' external rotation. The child could stand on the left leg by flexing the right knee. Strength of the muscles was good.

*Measurements:*

Anterior superior spine: right, fourteen inches; left, eight and one-quarter inches.

Angle of greatest extension: left knee, 160 degrees; right knee, 180 degrees.

Length of right tibia, five and three-quarters inches.

Length of left tibia, four and three-quarters inches.

*Roentgenographic Findings:* There is a congenital abnormality of the left femur with a complete absence of the upper half of the femur. The lower portion of the shaft gradually tapers to a point, and ends five centimeters above the epiphyseal line. The upper extremity of this rudimentary bone lies external and superior to the site of the acetabulum, which is undeveloped. The knee joint is clear and normal.

The right femur is normal in development, and measures sixteen centimeters from the upper to the lower epiphyseal line. The right hip and knee joints are normal.

From an etiological standpoint it is doubtful if syphilis plays any rôle. The second child born was normal. However, Bloom, Stone, and Henriques reported a case where lues was present. It can be seen that in future cases of this type it will be important to rule out any luetic factor.

As to treatment, it was planned to give the child a light brace to equalize the length of the legs. When the child grows a little older and stronger, and, if it is found that the hip joint is unstable, a shelf operation will be considered, with an implantation of a bone graft reaching from the ilium down to the shortened femur. Although this may not overcome all of the shortening, it should give a stable hip and the child would be able to wear a smaller brace.

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# SEPTIC ARTHRITIS IN THE HIP CAUSED BY BRUCELLA MELITENSIS

## REPORT OF CASE

BY ARCH F. O'DONOGHUE, M.D., F.A.C.S., SIOUX CITY, IOWA

It is not our intention to add to the already voluminous literature on Malta fever in this country, which has been sporadic for twenty-five years, and which in recent years is becoming endemic, especially in the Middle West. The disease has been well described by a number of writers, the first human case being reported about 1905. Since then Fortney<sup>1</sup>, Gillen and Gordinier<sup>2</sup>, Keefer<sup>3</sup>, Potts *et al.*<sup>4</sup>, Simpson and Bowers<sup>5</sup>, and numerous others have well described the disease. However, while practically all writers who observe more than one case note that there are arthralgic symptoms present in most cases, there are in the literature no reports of actual pus formation in joints with their destruction, except that by Kulowski and Vinke<sup>6</sup>, from Steindler's Clinic. We wish to add to the literature a case which recently came under our observation because we



FIG. 1

Preoperative roentgenogram, April 4, 1931, showing cloudiness over right hip area.

feel that—especially in the cattle-raising portions of the Middle West—septic joint involvements may often be due to Malta fever, and that joint infections from this cause are probably more common than has been suspected, especially since the differential diagnosis between septic monoarticular arthritis of non-specific origin, tuberculous arthritis, and some other types might easily be overlooked.

#### REPORT OF CASE

A white girl, aged twelve, living in northern Nebraska, came into the Lutheran General Hospital at Sioux City, in the Service of Dr. I. E. Nervig, on February 25, 1931. She complained that for the previous six weeks she had suffered afternoon rise in temperature, marked malaise, headaches, and occasional chills. Her family history was essentially negative. The family kept a number of cattle on the farm, but the father denied any abortions in the herd in recent months.

Her general examination was essentially negative, at that time, except for her very apparent loss of weight and rather exhausted appearance. Laboratory examination showed the urine to be normal, hemoglobin seventy-two per cent., leukocyte count 10,700 with a slight relative lymphocytosis; Wassermann, tuberculin, and Widal tests were negative, but the Malta fever agglutination was positive in dilutions of 1:160. She stayed in the hospital from February 25, 1931, to March 23, 1931, during this period being treated by Dr. Nervig by the use of intravenous mercurochrome, injections of which were followed by chills and temperature ranging up to 104. She left the hospital in March 1931, still running an afternoon temperature, but her general condition was much improved.

She came into the hospital again on April 1, 1931, complaining of excruciating pain in the right hip area with chills and fever. We were asked to see her on April 4, on which day our examination showed a very sick-looking girl whose general examination was negative, except that she lay with the right lower extremity in complete external rotation and about forty-five degrees' abduction, screaming with pain on the slightest movement of this hip, even touching the bed causing intense pain. Glands in the right groin were markedly enlarged and quite tender on slight pal-



FIG. 2

Postoperative roentgenogram, July 31, 1931, showing complete bony ankylosis



pation. The spleen was palpable and slightly enlarged. Other glands showed no changes. Laboratory examination on this date showed her urine to be normal, hemoglobin sixty-eight per cent., white count of 10,350 with thirty-nine lymphocytes and a positive agglutination test for Malta fever of 1:160. Comparative roentgenographic studies made of both hips showed slight cloudiness of the right hip joint with probable bulging of the capsule. We therefore advised and did a radical drainage of the hip on April 6, approaching the hip by the Smith-Petersen route. A large amount of thin pus was evacuated and, as the exposed head was pink, a gutta-percha drain was inserted into the posterior limb, the anterior limb being closed, and no Orr pack used. A culture taken from the pus removed from the wound showed no growth until the ninth day, when a typical *Brucella melitensis* was found by Dr. A. C. Starry of the hospital laboratory. A spica cast was applied immediately following the operation. The patient's temperature subsided at once and she left the hospital in the cast seventeen days after the operation. She was kept in plaster until July 31, 1931, on which date the cast was removed; all wounds were healed, and the roentgenograms showed a solid bony ankylosis of the hip. She was advised to wait a year or two and then have an arthroplasty done.

#### SUMMARY

A case of septic arthritis in the hip, caused by the *Brucella melitensis* and resulting in a solid ankylosis of the hip, is reported.

Malta fever joint infections must be added to the lesions calling for differential diagnosis of acute and subacute joint conditions.

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## OSTEITIS FIBROSA CYSTICA AT AN UNUSUAL AGE\*

BY EDWIN L. RYPINS, M.D., IOWA CITY, IOWA

Osteitis fibrosa cystica is generally regarded as a disease of youth (Bloodgood<sup>2</sup>, Geschickter and Copeland<sup>3</sup>, Platou<sup>9</sup>); and the common age is before twenty (Bloodgood, Platou), although Kilgore and Garland<sup>6</sup> report a case in a man of forty-six. We find few cases reported in infants. Thus, we believe the following case report may prove of interest.



FIG. 1

Appearance of right tibia on entrance. Note that the lower end of the fibula is almost fractured.

\* From the Department of Roentgenology, University Hospital, University of Iowa, Iowa City, Iowa.

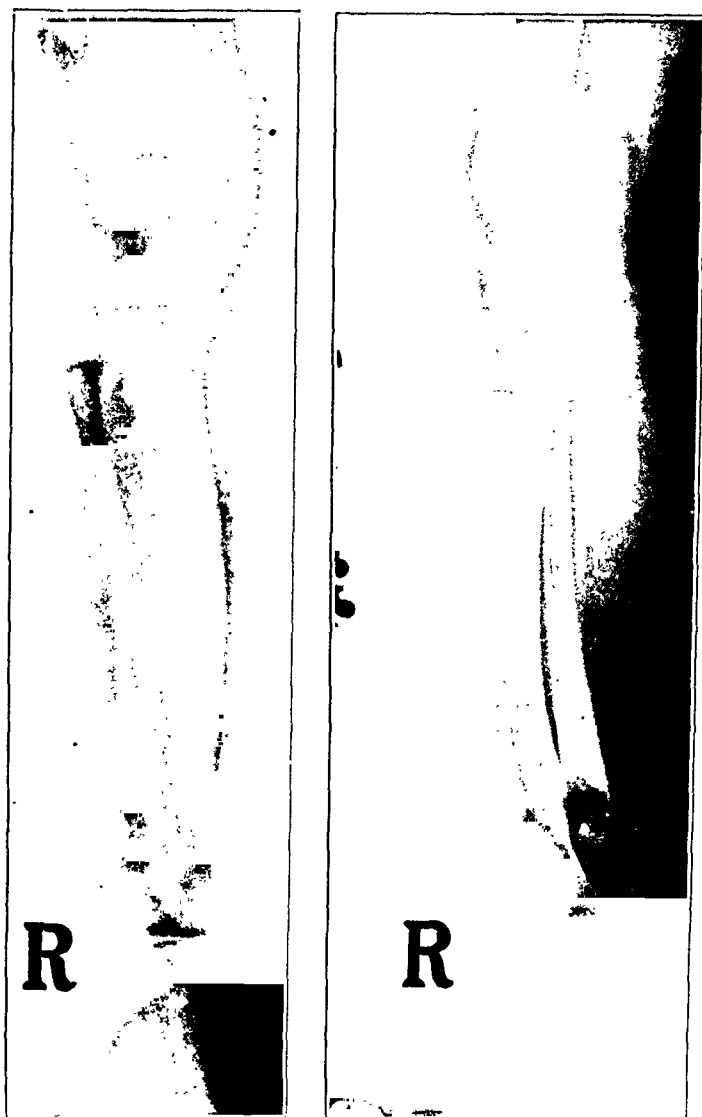


FIG. 2

Approximately ten weeks later. Note that the lower end of the fibula has fractured. There has not been any trauma in the interval.

R. S., female, white, American, twenty months of age, was admitted to the Orthopaedic Hospital of the State University of Iowa on December 18, 1931, Service of Dr. Arthur Steindler, complaining of pain and limp in the right leg. Symptoms dated from September 1931, at which time the patient first attempted to walk. The limp had been steadily progressive. Family and past history were negative. On examination the patient walked with the right leg externally rotated and the knee locked, as in quadriiceps weakness. The right tibia was bowed anteriorly and laterally, and thickened.

The tuberculin and blood Wassermann reactions were negative. The blood calcium was eleven milligrams; the blood phosphorus five and two-tenths milligrams. The right leg was placed in a cast for two months without improvement.

Biopsy of right tibia on March 13, 1932, showed osteitis fibrosa cystica. Guinea-pig injection of material failed to reveal tuberculosis.

Immobilization in another cast gave a great deal of relief, but one month of weight-bearing caused more bowing of the right tibia.

#### DISCUSSION

Burchard, as quoted by Joseph <sup>5</sup>, has roentgenographic proof of bone cysts in a child at eighteen months of age, and Joseph himself reports a case in which the patient was thirteen months old. In this latter case a biopsy of an inguinal gland was reported as metastatic sarcoma, which would make one suspicious that the bone lesions might also be malignant.

Apparently there is a close relationship between osteitis fibrosa cystica, bone cysts, and giant-cell tumor of bone, as Platt <sup>10</sup>, speaking of giant-cell tumor and osteitis fibrosa cystica, states, "The two lesions have a common histological denominator, the giant-cell area", while Geschick-

ter and Copeland<sup>3</sup>, state, "The average solitary bone cyst in the long bones is a healed or healing giant-cell tumor". Also, "the polycystic groups of osteitis fibrosa also emphasize the relation of the bone cyst to giant-cell tumor tissue, for in these lesions the small young cysts can be seen arising in giant-cell areas and fusing together to form the larger cavities".

The blood calcium was found to be normal; this test was done because, as Barrie<sup>1</sup> remarks, "Recent investigations seem to show that the parathyroids play a rôle in calcium content control. Faulty bone metabolism is quite generally believed to be due to an interference with endocrinal glandular equilibrium."

Furthermore, J. J. Morton<sup>8</sup> states that von Recklinghausen first regarded the disease as an inflammatory process whereby fibrous tissue was substituted for bone structure, while in his later work he changed this belief and thought that he was dealing with a metaphase of existing tissue and a calcium withdrawal.

However, Salmon<sup>11</sup> states, "Gold and Schlesinger find no parathyroid changes in localized osteitis fibrosa, but in the various generalized forms they find a definite association". Hunter and Turnbull<sup>4</sup> report four cases of focal osteitis fibrosa in order "to place on record the absence of any evidence of hyperparathyroidism in this disease".

E. G. Slesinger<sup>12</sup> gives two good theories regarding pathogenesis of osteitis fibrosa cystica,—(1) "It represents a metaplastic transformation of the bone marrow into a fibroid tissue; (2) it is the result of a chronic inflammation of unknown origin occurring in the endosteum." Furthermore, Slesinger feels that trauma is an important factor, a view not held by Bloodgood.

#### THERAPY

The close relationship of benign giant-cell tumors, which readily respond to radiation therapy, and osteitis fibrosa cystica would indicate that radiation therapy, as suggested by LeWald<sup>7</sup>, might prove of value in both conditions. We have not had an opportunity to treat this case.

#### SUMMARY

1. A case of osteitis fibrosa cystica in an infant, aged twenty months, is reported; reports of only two younger cases have been found in the literature.

2. Radiation therapy might prove of value in this condition, due to the close relationship of osteitis fibrosa cystica and giant-cell tumor.

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# THE USE OF UNNA'S PASTE IN THE MAGGOT TREATMENT OF OSTEOMYELITIS \*

BY E. L. JEWETT, M.D., HARTFORD, CONNECTICUT

*Hartford Hospital, Hartford, Connecticut*

In a review of the literature pertaining to the Baer maggot treatment of osteomyelitis, we find that the only substances used to cover the skin edges and hold the wire or gauze covering are adhesive tape, rubber plastic, or collodion. Most of the writers state that the patients have complained more or less of irritation of the skin by the maggots. We find that both adhesive and rubber plastic not only lead to irritation of the skin when removed, but that they also separate from the skin in many cases, thus allowing the maggots to creep up on the skin. As each series of treatments consists of a number of applications of maggots, with new covering each time, the above condition at times proves of real import. In one patient it was necessary to give quite large doses of antipruritics and hypnotics to enable him to be comfortable and sleep.

This led us to try Unna's paste as a medium to fasten the covering to the skin. The formula we used is:

Zinc oxid,  $2\frac{1}{2}$  parts

Gelatin,  $6\frac{1}{4}$  parts

Glycerin and water, each 19 parts

The solution should not be too thin, or it will run down over the leg and also into the wound, but when of the right consistency (this can be determined by trial) it seals the skin very effectively and also keeps the covering of wire or gauze glued down. Of course, it should be applied warm. We have seen no ill effects from a little of the paste getting into

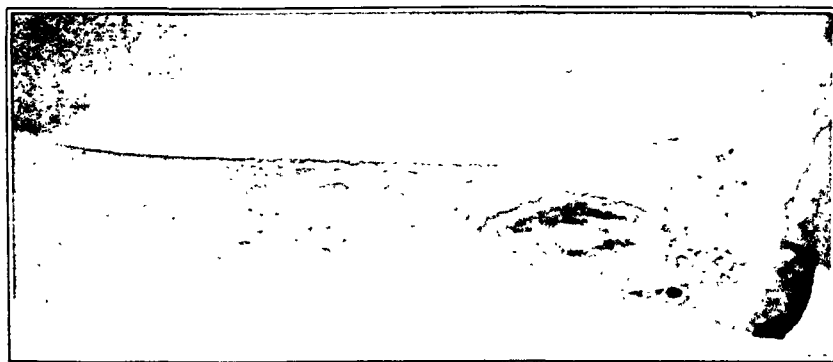


FIG. 1

Application of Unna's paste

\* Through the courtesy of Dr. John H. T. Sweet, Jr., on whose Private Room Service was developed the following method of application of wire retaining screen in the maggot treatment of osteomyelitis.



FIG. 2

Method of application of maggots to lesion.

the open wound. We found that the maggots could be implanted in the wound effectively by the use of sterile gauze applicators which had been dipped in the maggot suspension. If the maggot-laden applicators are left in the wound for a moment or two, most of the maggots wander off from the cotton into the wound.

At first we used thick felt as a framework on which to put the wire gauze and this seemed to work very well, if the felt was thoroughly saturated with the paste and all the crevices closed with the paste. Later on we discontinued the use of the felt, just using ordinary gauze. The



FIG. 3

Showing one wire screen covered with Unna's paste and gauze and another screen with edges turned down, to be applied to lesion on opposite side of leg. Adhesive tape has not yet been applied.

edges of the wire should be turned over so that no loose strands are left free to cause irritation to the underlying skin. After the wire is fitted over the lesion, more layers of Unna's paste and gauze are placed, overlapping the wire edges. Then, as a final covering, adhesive tape is placed over the gauze. In cases where there is any question of the covering not being tight, ordinary gauze bandage may be wound firmly around everything else and left on until the paste thoroughly hardens. A few layers of gauze left over the wire mesh for a few hours are not enough to keep out the air.

The advantages of this covering are as follows:

1. It produces no irritation to the skin.
2. The paste can be placed close to the open lesion and all cracks and crevices effectively sealed off, thus confining the maggots to the lesion. The secretions from an osteomyelitic lesion often saturate the adhesive tape and cause it to separate from the skin. These secretions themselves are somewhat irritative to the skin. This paste protects the skin from these secretions.
3. It can be washed off easily with warm water and this leaves the skin in excellent condition.



# TREATMENT OF VOLKMANN'S ISCHAEMIC PARALYSIS BY ELASTIC TRACTION

## REPORT OF SEVEN CASES \*

BY ATTILIO MILICI, M.D., NEW YORK, N. Y.

Since 1928 the writer has treated seven cases of Volkmann's paralysis with elastic traction. Though traction is not a new method, and the means by which it is applied has been used by others, these cases are being reported because of certain details which have made this form of treatment more effective. The splint (Fig. 1), made of an ordinary metal that is not too pliable, consists of a proximal part (A) for the forearm and a distal part (B) for the hand, the two connected by an ordinary door-hinge (a),

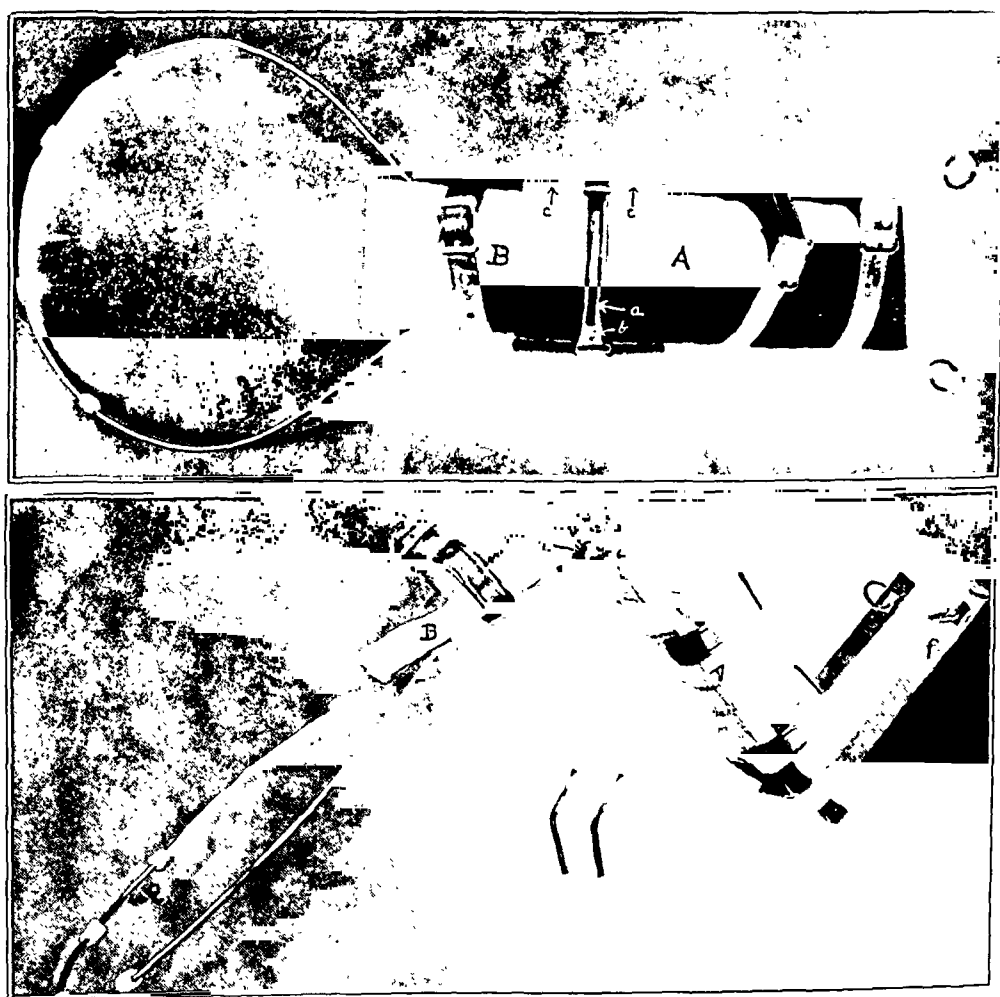


FIG. 1

Splint. A. Proximal portion for forearm. B. Distal portion for hand and fingers. a. Ordinary door-hinge. b. Removable pin of door-hinge. c. Grooves for insertion of removable pins. d. Removable pins which can be bent to any angle. e. Wire loop for extension. f. Vertical bars for traction on distal portion of splint.

\* From the Children's Surgical Service, Bellevue Hospital, New York City.

so that the distal part can be moved on the proximal to any desired position. A removal pin (*b*) in the hinge makes it possible to separate the two parts of the splint by simply pulling the pin out.

At the wrist the two parts of the splint on either side have a groove (*c*) through which a small metal rod (*d*) can be inserted, thus immobilizing the movable part of the splint. (Metal rod *d* is inserted in the grooves *c*.) Immobilization of the distal part of the splint in any desired position can be accomplished by simply bending the rod (*d*). A loop of wire (*e*), spreading out banjo-fashion from the end of the splint, serves as a medium to hold the elastic traction. This wire loop is removable, being held in position by slots in the distal portion of the splint.

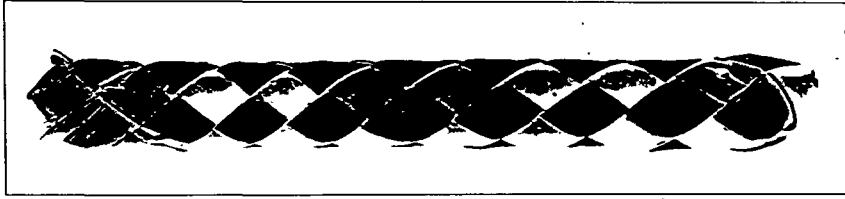


FIG. 2  
Japanese finger trap, used for extension.

Traction is made on the fingers by means of the so called Japanese finger traps (Fig. 2). These finger traps are made of woven straw and are intended to be used as trick toys. Inserting a finger of each hand on either end of the toy it is impossible to extricate them, as the more one pulls, the tighter the grip becomes; the fingers, however, can be quickly released by approximating the two ends of the finger traps towards each other. We make use of these traps by attaching a piece of Esmarch's bandage to one end and inserting the other end over the finger. Traction is made by the pulling of the rubber which in turn is fastened to the banjo wire by an ordinary curtain hook (Fig. 3). The amount of tension exerted is regulated by lengthening or shortening of the rubber band. The fingers are covered with strips of adhesive plaster to protect them from the slight roughness of the straw and also to obtain a firmer grip. The great advantage of these finger traps is that they can be instantly applied; can be removed as quickly; they hold on the fingers is firm; and, on account of their great resiliency, they do not interfere with the circulation of the part.

The traction is begun on the fingers by immobilizing the splint in the position in which the fingers lie, and is continued until their complete extension in that position is attained. The angles of the immobilizing pins are then changed into less acute ones, thus immobilizing the palmar portion of the splint a few more degrees toward dorsiflexion, and traction again is made on the fingers until they are straight in this particular plane; immobilization is thus gradually changed into a more dor-siflexed position and traction continued until both wrist and fingers are on the same horizontal plane (Fig. 3).

It has been learned from experience that the elasticity of the muscles in these cases is greatly diminished, and that the tendency to correction increases with improvement of position.

In all of the cases it was found that after the wrist and fingers were corrected to a horizontal plane, no further progress could be made. It was considered advantageous at this stage to discontinue traction on the fingers; to remove the immobilizing pins (*d*), thus allowing the distal part of the splint to move on the proximal; and to make traction in a dorsiflexed position on the wrist by the use of an ordinary Esmarch's bandage attached to a vertical bar (Fig. 1, *f*) on either side of the splint near the elbow and on the banjo wire at the finger end of the splint (Fig. 4), the Esmarch being regulated so as to have a slight tension at all times. It has been found more practical at this stage to encase the splint and the forearm in plaster-of-Paris, first removing the straps, which up to this time, have been used (Fig. 4).

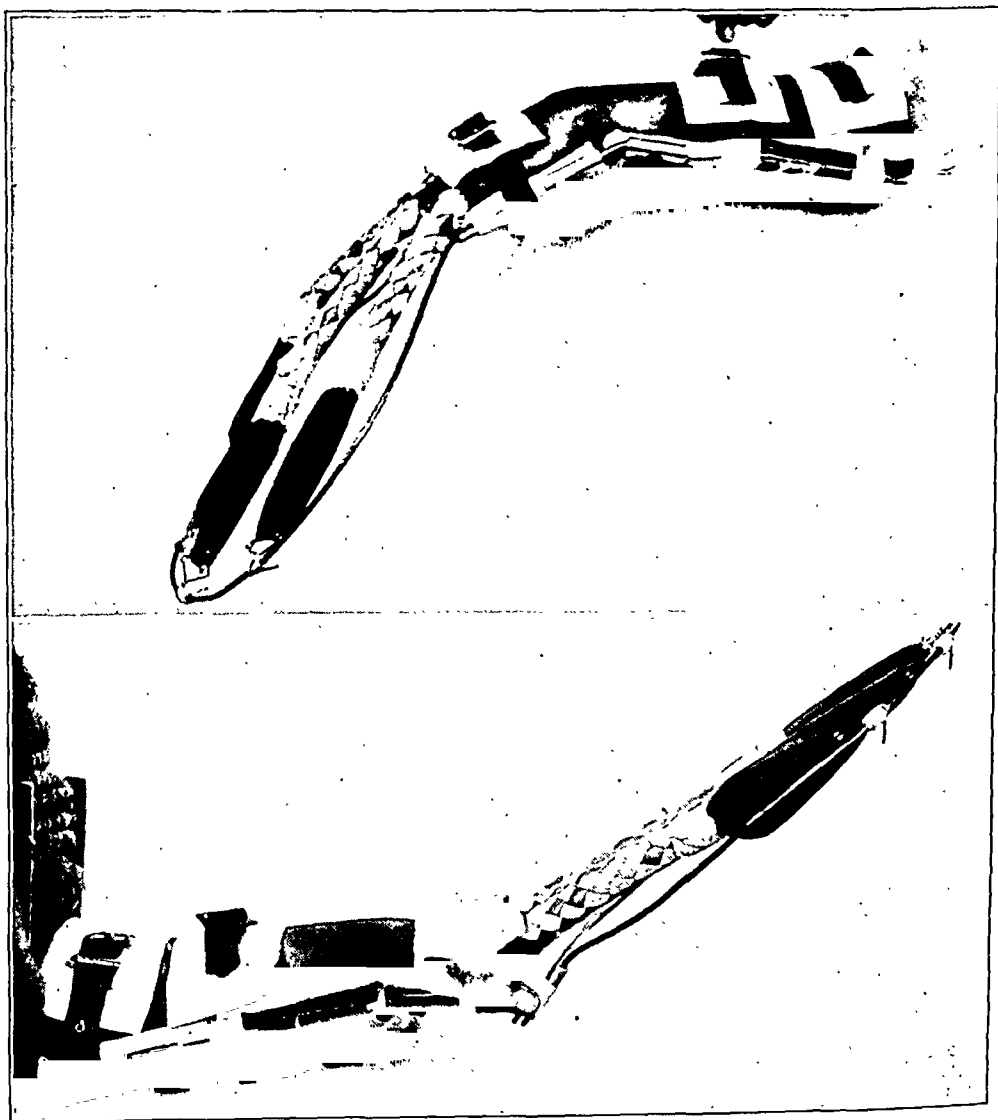


FIG. 3  
Splint applied to hand.

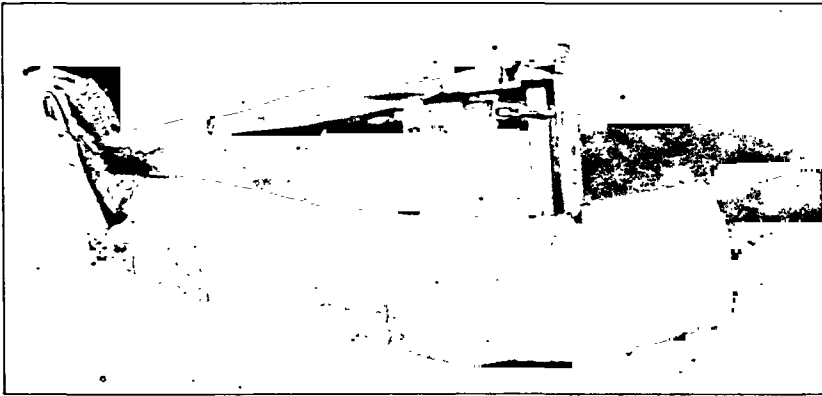


FIG. 4

Straps have been removed from splint, and splint and forearm encased in circular turns of a plaster bandage, traction being continued upon the distal portion of splint exerting dorsiflexion of wrist.

As dorsiflexion improves, the Esmarch is gradually shortened to keep up the tension, which is maintained continuously until complete dorsiflexion of the wrist is accomplished. The wrist is next immobilized in this position by incorporating the distal portion of the splint in the plaster (Fig. 5), and traction renewed on the fingers which by this time have again become flexed. Dorsiflexion of the fingers is then gradually increased until they themselves are in complete dorsiflexion. Forearm, wrist, and hand are then encased in a plaster-of-Paris splint in the corrected position, and so maintained from four to six weeks. No immobilization was used in our first case after complete correction; three weeks later the deformity was found to be almost as bad as before treatment was



FIG. 5

When complete dorsiflexion of wrist has been obtained, the wrist is immobilized in this position by circular turns of plaster bandage about the distal portion of the splint and hand, and traction is again made on the fingers.



FIG. 6-A

Case 1. X-ray of right forearm on admission.



FIG. 6-B

Result, six months later.

commenced. It is, therefore, of vital importance to always immobilize these cases after their correction.

Experience has shown that the prognosis in these cases, is, to a large degree, dependent on the amount of muscle tissue that is viable and capable of contracting. As a rule, the older the case the more marked the fibrosis; on this basis many authors consider that cases of several months' duration can be benefited only by operation, and that only early cases are amenable to daily massage and muscle stretching.

It is the belief of the writer that all cases can be helped by this

method, no matter how old or how marked the deformity. The deformity can always be corrected, but it is not known how much function will be obtained, as this depends to a large degree on the amount of muscle tissue viable.

Constant, continuous elastic traction, aiming at stretching of this scar tissue, thus overcoming the deformity and leaving unhampered whatever muscle tissue there is viable, is the rationale of this treatment; traction is maintained day and night, the tension being so regulated as to cause little or no pain; in fact, pain and discoloration of the part mean that the tension is too great and should be reduced. It has been found that the results obtained by this method are superior to those achieved by any of the several operative procedures; a remarkable degree of restoration to function is often accomplished in cases that, in the beginning, seemed hopeless.

#### CASE REPORTS

CASE 1. L. S., boy, eight years old, was admitted to the Hospital September 5, 1930, with a typical claw-hand deformity. There was flexion of the wrist, extension of the metacarpal phalangeal joints, and flexion of the interphalangeal joints. There was some wasting of the muscles of the hand and forearm, but most pronounced atrophy was present at the thenar eminence. The child complained of severe pain on manipulation; no active motion of the hand or fingers was possible. The history was that of a supracondylar fracture of the humerus three months before admission, treated in another hospital in splints with flexion at the elbow for a period of three weeks. This patient was discharged on March 8, 1931, completely cured. It is impossible now to distinguish between the pathological and the good hand.

CASE 2. W. E., boy, eleven years old, was admitted to the Hospital November 23, 1929, with a history of injury to left forearm in August, 1929, due to a fall. Cast had been applied for four weeks in another hospital. Typical deformity was noticed on removal of the cast. Examination showed the right hand held in claw attitude with marked flexion at the second phalangeal joint, extension impossible, and practically no motion of the wrist. Sloughing of the little finger was noticed a few days after admission. Neurological examination showed involvement of the ulnar nerve and neurolysis was attempted a few weeks afterwards with some improvement in sensation over the ulnar distribution. Marked trophic changes subsequently developed in all the other fingers, so that application of the splint had to be delayed until all the sores had healed. This patient was discharged on August 30, 1930, with a hand that was quite useful, extension being complete. His grip was good, and now he can use the hand with almost as much ease as before his injury.

CASE 3. S. M., boy, nine years old. This patient was admitted on March 27, 1928, with a history of a supracondylar fracture four months before admission. He was treated at another hospital for six weeks with plaster-of-Paris molded splints, with the resultant deformity. Examination showed a typical claw-hand deformity, with marked flexion at the wrist and interphalangeal joints; practically no movement at the wrist, slight motion of the fingers. There was marked atrophy of the interosseous muscles of the hand and some atrophy of the muscles of the forearm; sensation was lost over the distribution of the median and part of the ulnar nerve. Trophic changes were present in all the fingers. Roentgenograms showed old supracondylar fracture of the humerus with slight backward displacement of the lower fragment.

This boy was discharged on August 17, 1928, markedly improved. The result in this case is not as good as in some of the others, which fact we attribute to an almost complete destruction of the muscle tissue of the forearm. However, the boy can use his hand



FIG. 7-A  
Case 2. Before admission.

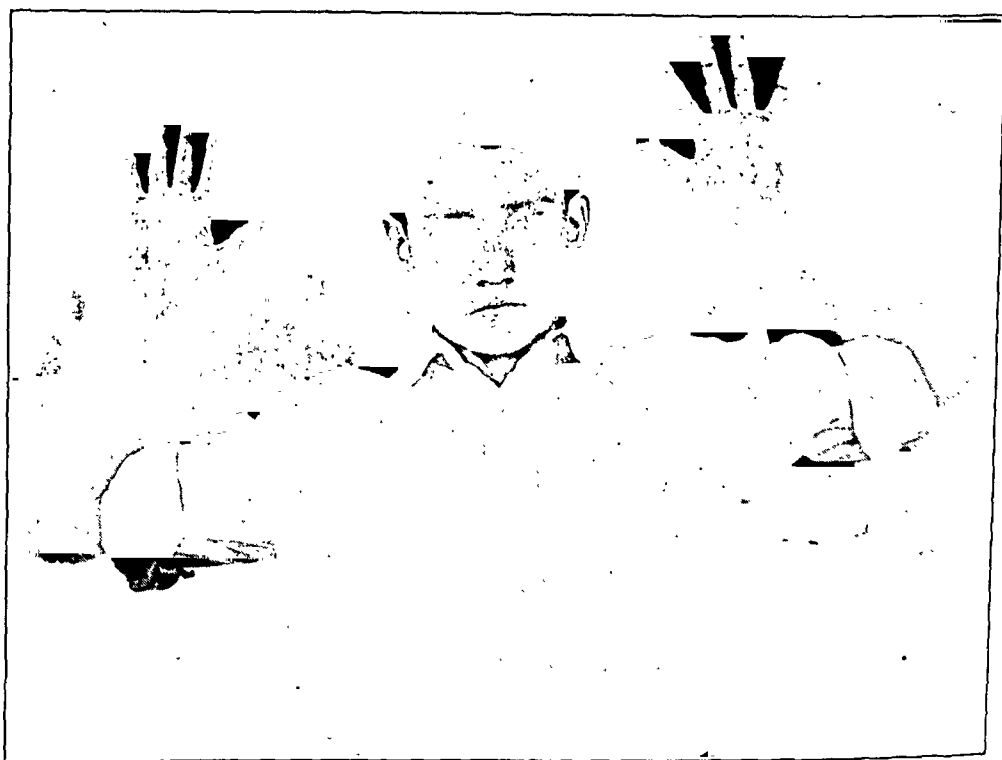


FIG. 7-B  
After treatment, seven months later.

fairly well. He can write, carry objects, handle a knife and fork, and do almost everything with it, but his grip is very poor.

CASE 4. R. S., boy, eleven years old, was admitted September 30, 1929, with a



FIG. 8-A  
Case 3. On admission.



FIG. 8-B  
Four years later.

history of having fallen six feet in August, 1929, landing on the left forearm. A dislocation of the right elbow was reduced in another hospital, where it was found that he also had a fracture of the lower end of the radius. A plaster cast was applied to the forearm after reduction, which was not successful. An open reduction was subsequently done and the forearm placed in a cast for five weeks. A typical Volkmann contracture was found on removal of the cast. Examination showed a two-inch scar on the arm of the



wrist over the radius. There was a large amount of firm callus at the site of the fracture.

Wrist was held in acute flexion with typical claw-hand deformity. No active motion was possible, either of wrist or fingers; passive motion of the wrist of about fifteen degrees. Wrist was very painful. No sensory disturbances. Roentgenogram showed an old comminuted fracture of the lower extremity of the radius with backward displacement of the radial epiphysis. This boy was discharged on February 4, 1930, completely cured.



FIG. 9-A



FIG. 9-B

Case 4. FIG. 9-A: On admission. FIG. 9-B: Six months later.

CASE 5. M. D., boy, seven and a half years old, was admitted with a history of a supracondylar fracture of the humerus six weeks previously. He had been treated elsewhere with a plaster cast which was left in place uninspected for five weeks, at the end of which time the typical deformity was found. Examination showed marked flexion of all the fingers, with marked atrophy of extensor and flexor groups of muscles; marked limitation of movement of the wrist and fingers. Roentgenograms showed an old fracture of the lower fourth of the radius and ulnar, with slight backward displacement of the lower fragment. This patient was discharged on November 2, 1931, with a hand that is practically normal.

CASE 6. C. L., boy, eleven years old. Patient was admitted on February 2, 1932, with a history of fracture of the left humerus, lower fourth, one year ago. He was treated for three weeks with plaster-of-Paris splints with elbow at right angle. On removal of splints he was found to have an ankylosed elbow and wrist-drop. Examination showed a left forearm held in flexion at an angle of eighty-five degrees, with practically no motion. Triceps muscle, all of the forearm muscle, and hand muscles were markedly atrophied. There was complete wrist-drop with claw-hand. This boy is still under treatment. Correction of wrist and hand to a more horizontal plane have been accomplished.



FIG. 10-A  
Case 5. On admission.



FIG. 10-B  
Eight months later.

CASE 7. J. B., female, aged forty-five years. This patient was a private case. She had a Colles' fracture in July, 1928, and was treated by another doctor with plaster-of-Paris molded splints, which were kept on, uninspected, for five weeks. On removing these splints, a typical claw-hand deformity was noticed. When seen by the writer in January, 1929, she showed marked flexion of the wrist and fingers. There was very little movement of the fingers and practically none of the wrist. There was marked atrophy of all the muscles of the hand,—in fact, the hand was quite useless. X-ray showed an old Colles' fracture with marked posterior displacement of the lower fragment. It also showed atrophic changes in all of the carpal bones. She was under treatment for exactly one year, with good functional result.

I am indebted to Dr. Carl G. Burdick and Dr. Fenwick Beckman for permission to report these cases and wish to express my appreciation for their help and encouragement.

# WALKING MEMBERS FOR BILATERAL AMPUTATION OF THIGH

BY THOMAS F. WHEELDON, M.D., RICHMOND, VIRGINIA

The writer has had several cases of bilateral amputation of the thigh, just below the trochanters of the femora, for which he has used different types of supports. None seemed entirely efficient until the present type, herewith illustrated, was designed. The material used in the construction of these supports is light, rustless steel, the wearing quality of which has been excellent. The treads are large and firm; and the patient wearing them gets around splendidly with wonderful balance. There has been no difficulty either in getting a patient to wear this apparatus or in teaching him how to do so, and, as it places the wearer close to the ground, there is very little fear of falling. After the patient gets used to this length of support a taller one can be used without difficulty, if for any reason such is desirable.

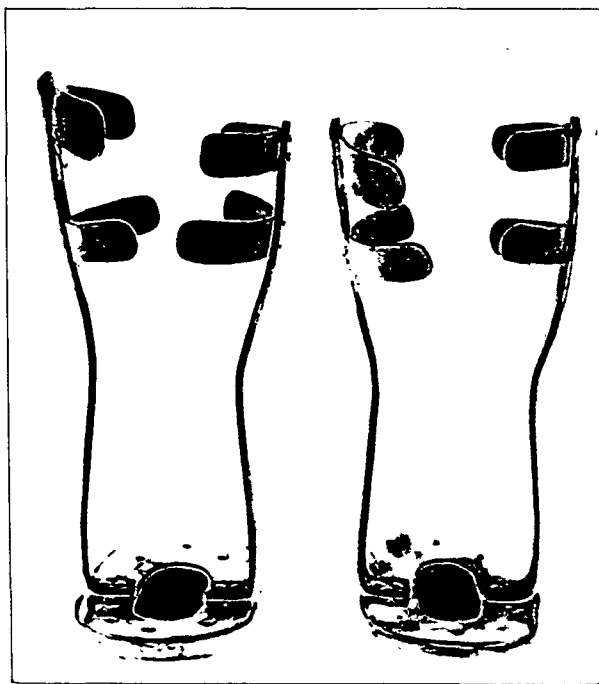


FIG. 1

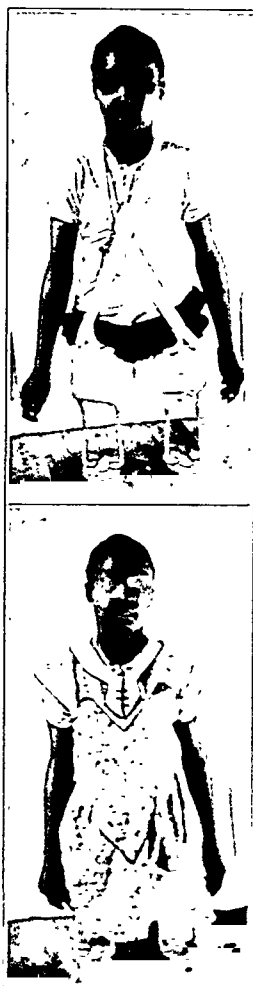


FIG. 2

## A SPLINT FOR FRACTURES OF THE LEG

BY HARVEY C. MASLAND, M.D., PHILADELPHIA, PENNSYLVANIA

The illustrations present a splint construction for the reduction of a fracture of the leg, more particularly for the upper third. For the lower two thirds of the leg, an unpadded plaster cast, extending from the fulness of the calf muscles over the flexed knee and well up on the thigh, is substituted for the upper portion of this splint.

The buttock ring is of two metal, semi-elliptical strips properly prepared for adjustable connection with each other. The ring is fitted to rest snugly upon the skin surface throughout its circumference. It bears upon the ilium, the ischium, and the pubic bone. It is covered with felt over which an artificial leather bandage is applied tightly and smoothly. This is anointed with some emollient ointment, such as cold cream.

The thigh splint arms, in two pieces on each side of the limb, are adjusted to the length of the femur. Their upper ends are angulated to give the correct tilt to the buttock ring. They are attached to the ring before the felt is applied.

Two metal strips are bent to form an adjustable stirrup which is encased in the slipper plaster cast. The ends of this stirrup flare out over the malleoli. The leg splint arms, also in two pieces, are attached to the slipper cast and to the thigh splint arms in the axes of the respective joints. An aluminum gutter splint, of ample proportions, is laid along the posterior length of the femur, and held tightly to the splint arms with adhesive plaster. A brace, spanning the knee joint, locks the joint against movement in the subsequent distention.

For the distention, a turnbuckle assembly is attached to the overlapping leg splint arms. With the immediate reduction of a fresh fracture, complete correction of the overlap can be expected as routine. A gutter splint, or splints, is applied to the fracture, both for support and for the correction of any tendency to lateral deviation.

The splint equipment here illustrated is very simple. The pieces are selected from a portable outfit which is complete for the splinting and reduction of a fracture of any bone of either limb. In this equipment there is an assortment of four different lengths of metal splint arms, and three different lengths for construction of the rings for the shoulder, the buttock, and a clavicle-chest ring. There are a few brackets, sleeves, etc. for general purposes and some special pieces for the patella, the olecranon, the carpal, tarsal, metatarsal, and metacarpal bones; also a device permitting rotation of the forearm within the splint. The instruments comprise a pair of special bending wrenches, plaster instruments, and some miscellaneous tools purchased in the hardware store.

The plan of assembling the splint pieces and the mechanical principles involved are clearly shown by the illustrations. In the fracture of any long bone of either limb, the principle of securing a safe, well dis-

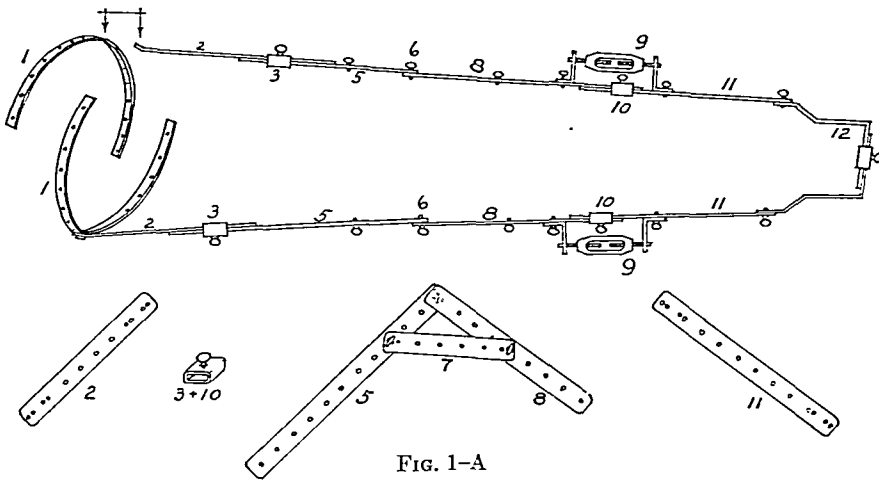


FIG. 1-A

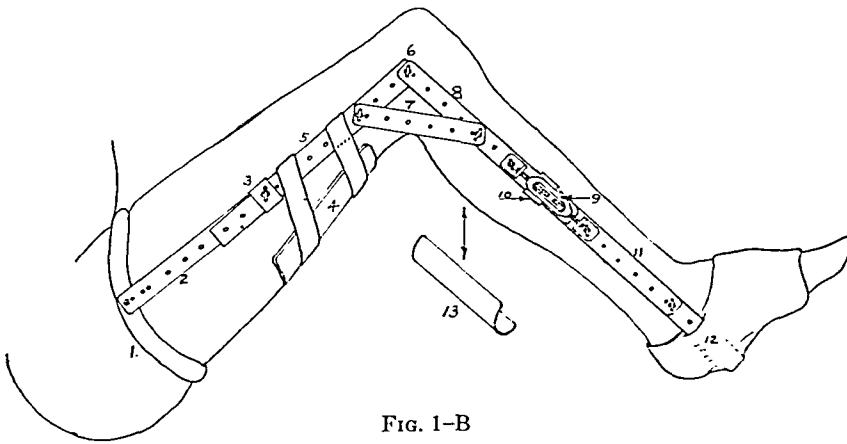


FIG. 1-B

Similar numbers indicate similar parts.

1. Adjustable buttock ring.
3. Clamping sleeve enclosing 2 and 5, the overlapping thigh splint arms.
6. Pivoted joint at the knee.
10. Clamping sleeve enclosing and holding the leg splint arms in any degree of distention.
9. The turnbuckle assembly for the distention.
2. Adjustable foot stirrup encased in the plaster slipper cast.
7. A temporary knee-joint fixation brace.
13. A supporting splint for the fracture.
4. Pressure gutter splint against the femur.

tributed, and sufficient support upon adjacent skeletal structures is followed. As the splint has stabilized the bone, the subsequent distention produces a smooth sliding backward of the displaced bone into normal position. There is no pain and only in some complicated cases is there need for an anaesthetic.

Subsequent adjustment of the splint is very simple. The splint design permits immediate or very early function of the adjacent joints, without disturbance of the immobilization of the fracture.

# AN APPARATUS FOR EXERCISING PARALYTIC LIMBS

BY JAMES C. WILSON, M.D., HARTFORD, CONNECTICUT

During the epidemic of 1930, at the Municipal Hospital at Hartford, Connecticut, we had fifty-two cases pass through the Orthopaedic Ward, which were in need of treatment calling for underwater exercise. At the Hospital there was installed a very satisfactory tank, but to exercise the twenty or more patients at frequent enough intervals was impossible, due to lack of time.

Notwithstanding the opinion of some men that a long rest period is necessary before starting exercises, the author can see no reason for delaying the exercises after the period of irritability is passed. Prevention of contraction, preservation of nutrition and general condition demand exercise, and no other method can take the place of attempted voluntary motion. In motion there are two distinct impulses given, one for contraction of the intended muscle, and one for the relief of tension in the opposing muscle. Only by attempted voluntary motion do these two impulses coordinate and tend to give the balance of power needed about the joint.

In view of the fact that limbs that could not otherwise move might show some impulse when raised from the bed, we made use of some bars passing through the ward, over the beds. By suspending a limb by means

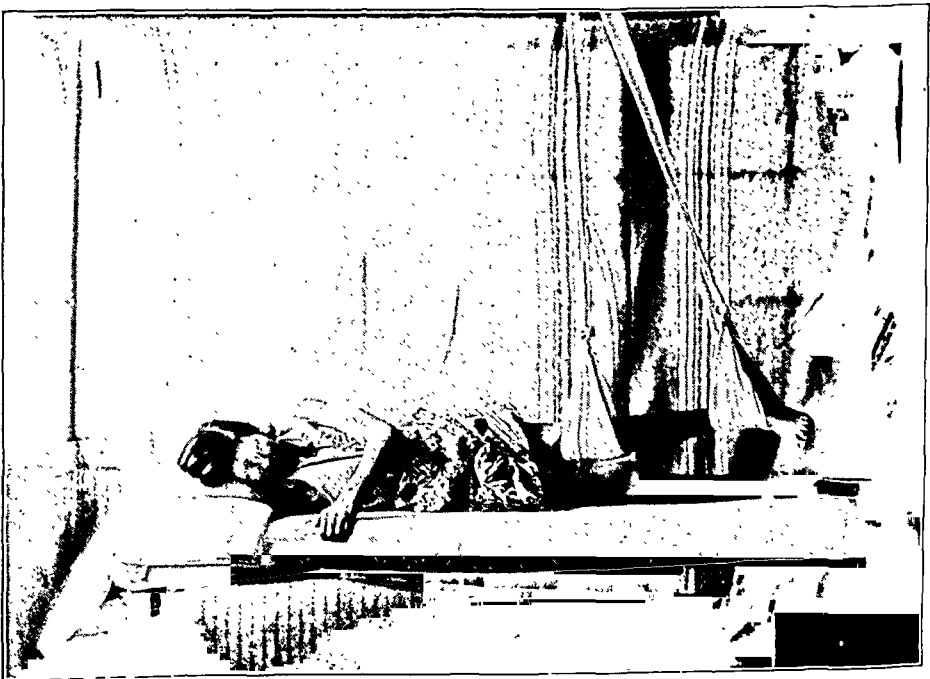


FIG. 1

Leg in sling to exercise hip and knee group. Patient too weak to move limb when on back but does very well when on side.



FIG. 2

Showing arm in sling to exercise abductor and adductor groups at shoulder.

of a muslin bandage it was possible to relieve the limb from the force of gravity, as in the tank, and a very good type of exercise could be given. In fact, there was no motion which could not be carried out, except that involving the back, providing there was any power left.

The position in which the exercise may be given to the best advantage depends somewhat upon the operator. Flexors of the thigh, for instance, when too weak to draw up the knee may be exercised at the



FIG. 3



beginning with the patient on his side. Arms and hands may be suspended in the sling with the patient either sitting or lying. Every motion possible to attain in the tank may be duplicated in the sling. The sling has these advantages over the tank:

1. Frequency of exercise (sometimes as much as three or four times a day), always approaching fatigue but never reaching it.
2. The example to smaller children of the older patients who can understand just what we want them to do; the smaller children eventually accept the exercise as a game.
3. The possibility of exercising any number of patients at the same time without removing them from their beds.
4. The possibility of its use in the private home where it is a cheap, simple, and very efficient piece of apparatus.

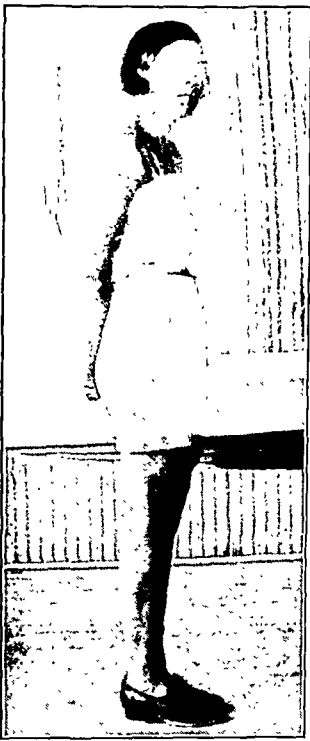


FIG. 4

Result after two months of treatment for severe back-knee.

The degree of atrophy in the limbs so treated was much less marked than seen in the patients who came into the clinic and who had not been so treated. Braces for the prevention of deformity during this intermediate stage of the disease were less frequently needed, relieving the limb of any constricting bands or bandages which can only restrict circulation. Of course, these cases were kept under close observation for such deformity as might occur, and, in case the limb could not be easily held in the normal position after it had been out of the sling for twelve hours, braces were applied.

As to the apparatus: It is simply a gauze bandage or other sling placed over a bar or hook above the bed. For a bar, a Balkan frame or curtain pole may be used, or a heavy hook or ring placed in the ceiling over the bed will serve the purpose. This apparatus has also been used to advantage to free up shoulders after fracture, and in other conditions where voluntary effort has been desired to increase motion.

The tank has been the means of starting many patients who otherwise would have been considered totally paralyzed; but there are many places where the tank is not available on account of the location of the patient or the overcrowding of the wards, and, in the author's experience, the sling not only does everything the tank can do, but may be used anywhere with considerably less trouble.

# AN ORTHOPAEDIC AND FRACTURE TABLE EMBODYING NEW PRINCIPLES

BY WILLIAM LISLE BELL, M.D., OAKLAND, CALIFORNIA

The table illustrated is supplied with a solid sacral support which is rarely, if ever, used, once the operator becomes familiar with the soft, fiddle-string tight, double-layer, longitudinal, canvas support, split at its foot end for the introduction of a padded saddle.

Figure 2 shows angled top view of this tight supporting canvas when properly placed.

Figure 1 gives one view of foot piece, and method of positively bandaging foot to foot piece. This mechanism permits any angle of rotation or ankle flexion, and locks positively in any position.

Figure 3 illustrates sliding extension spars capable of use throughout the full length of the table. These spars apply traction at any angle to either legs or arms.

Figure 4 pictures padded axillary hooks, useful for spinal distractions with patient prone or supine, and for lessening perineal pressure against saddle during leg or hip traction.

Figure 6 shows foot piece with patient prone (fully as efficient). Note straight body line with tightly drawn canvas.

Figure 5 shows the canvas relaxed. This may be done gradually, and locked anywhere instantly. Proper support is provided with one of the cross tables under the knees. Extreme posterior concavity is readily obtainable by this method.

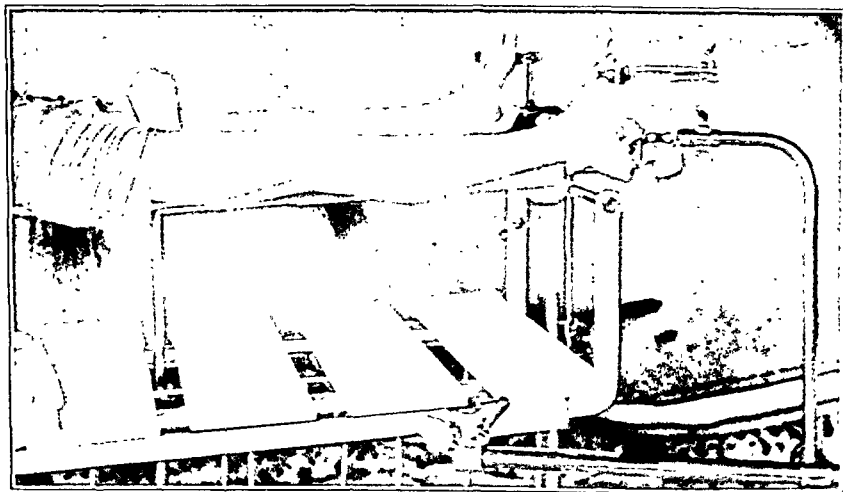


FIG. 1

Foot is shown bandaged obliquely, with bandage engaged in tooth on bottom of foot pan. Saddle and stud are in place. Padded plantar plate at base of toes maintains any degree of dorsal flexion or rotation.

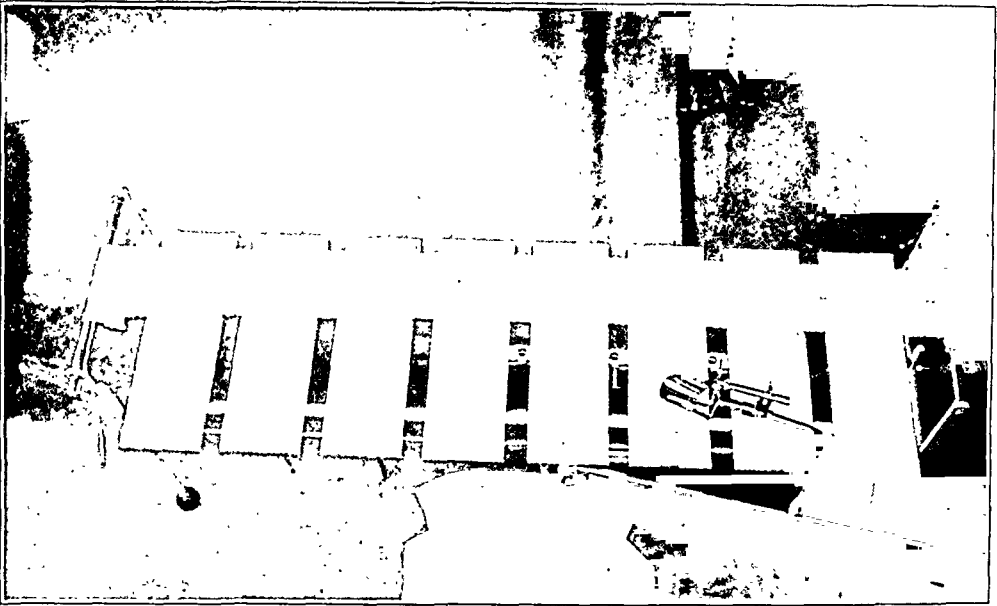


FIG. 2

Canvas shown is wider than needed. There are three holes for saddle stud under cross tables. Powerful, split, accurately adjustable windlasses wind canvas over top. Note slit in canvas to permit introduction of saddle stud.

Figure 7 illustrates the method of application of Böhler's os calcis traction, and application of plaster case without extra equipment. Patient rests on all cross tables lowered to frame during this operation.

All cross tables are raised and covered with sterile blanket when

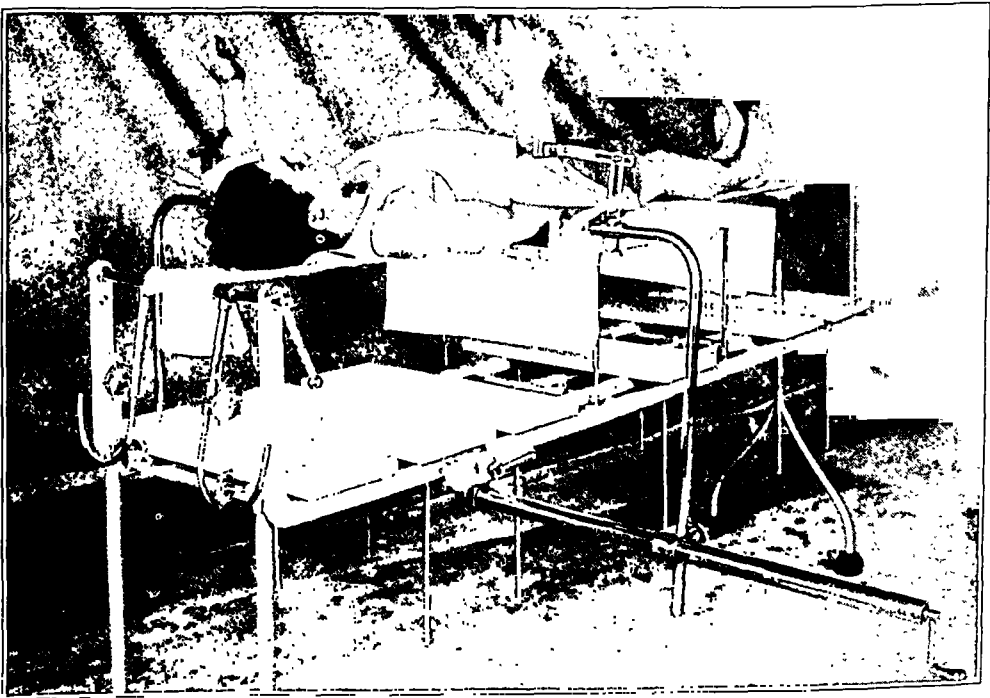


FIG. 3

Leg spars moved up to shoulders. Shows arms in traction, at right angles to body axis. Rotation is controlled. Still greater abduction is possible if needed. Fully accessible for plaster.

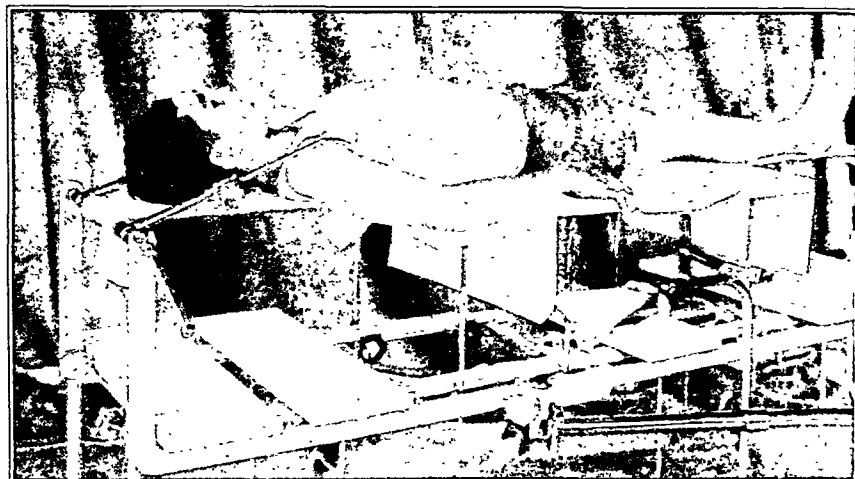


FIG. 4

Adjustable axillary hooks, padded, divide and lessen perineal pressure and permit spinal traction when perineal post is removed. Few cross tables are elevated. Feet should be bandaged in foot pieces.

patient is placed on canvas. After this the necessary number of cross tables are instantly lowered singly, or in any combination desired. This lowering is accomplished with ease from either side, or both sides of the table. Patient rests at all times on soft, non-bruising, non-metallic support, fully accessible for plaster-of-Paris throughout full length, base of the neck to heels. The canvas is ignored throughout operation, after which it may be cut and removed. The patient may remain supported upon this canvas without sacral or perineal injury until the plaster case is safely set. This makes for lighter plaster encasement. With fractured



FIG. 5

Shows use when posterior spinal concavity is indicated. Proper support above the knees is provided. This represents about half the curvature obtainable by this method

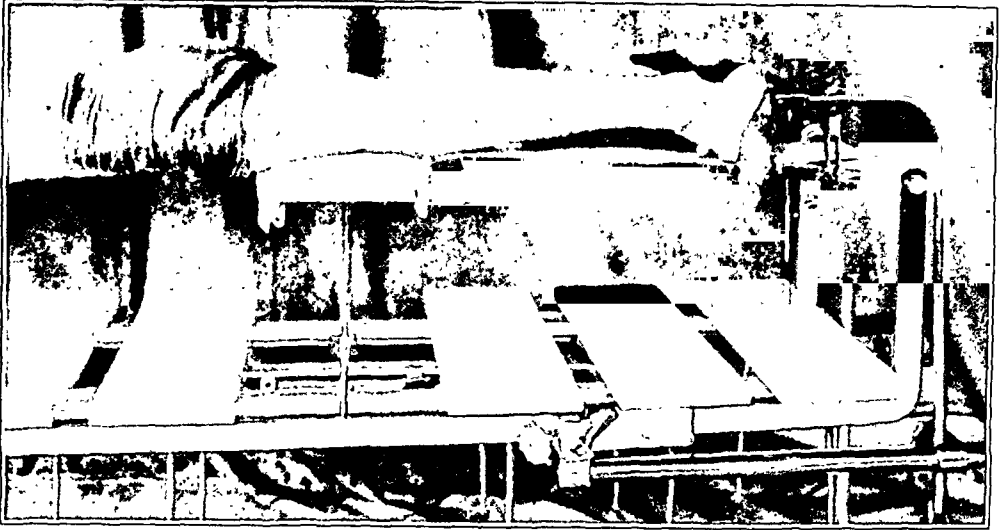


FIG. 6

Shows patient prone and one cross table elevated. Foot piece is equally efficient with toes downward and is positively lockable at any angle.

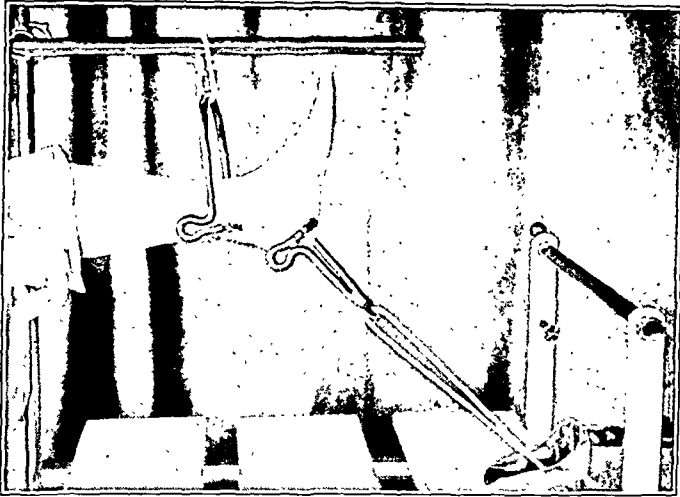


FIG. 7

Quick acting saddle support device for Böhler or calcis traction. Foot pan may be instantly adjusted at any angle for traction. Various types of nails or stirrups may be used.

hips, it is quite possible in many cases, to reduce and encase without general or local anaesthetic. Only the hypodermic is used, resulting in less shock, gentler manipulation, very accurate control, no sacral injury.

This table possesses removable, lockable legs; is light and very strong; occupies but two square feet on its end when not in use; takes the place of several tables, a number

of pieces of traction and manipulation apparatus; is completely housed from plaster drip; has full-length traction for arms, as well as legs, and at all possible angles. The table may be used for the treatment of any patient, from an infant to an adult seven feet in height.

One or both feet may be encased in light plaster boots preceding traction, and rested in foot pans during manipulation. These plaster-of-Paris boots may be firmly anchored to vertical studs of foot pieces. When the attachments to foot pans are cut, after splinting is completed, the foot is held in accurate position by the foot pan. In other words, the foot does not drop.

This table embodies in one unit of equipment clinical control of a

very wide range of fracture requirements. It has been tested clinically and mechanically through various models for twelve years.

The idea of a longitudinal canvas support came to most of us through a frame given us by Dr. E. H. Bradford. This particular use, however, so far as the author is aware, has not been applied to orthopaedic tables. It must be remembered that this canvas is split, is in combination with the saddle, permits traction and full accessibility of the patient, and must of necessity be an integral part of a device solely designed to meet all these requirements. The avoidance of sacral pressure in heavy, elderly patients is no small consideration.

This device was shown by the author at the meeting of the American Medical Association in 1926. Since that time a certain number of refinements have been added.

# EPIPHYSITIS OF THE PROXIMAL OR PSEUDOMETATARSAL EPIPHYSES OF THE FOOT

## REPORT OF A CASE\*

BY M. S. BURMAN, M.D., NEW YORK, N. Y.

Epiphyses are present occasionally at the bases of the metatarsal bones, and Sawtell<sup>1</sup> notes that similar epiphyses may exist in the hand coincidentally. Irregularity in the formation of the bones of the foot is not noted after the age of five years and six months. These accessory or "pseudo-epiphyses", as they are termed by anatomists, have no particular significance. Sawtell believes them inherited; others regard them as due to an endocrine disturbance. Köhler<sup>3</sup> points out that these proximal epiphyses are always present in man in the primitive formation, but that fusion takes place early with the ossifying diaphysis.

It was noted previously<sup>2</sup> that no case of disease of the pseudo-epiphyses had ever been reported. We are reporting now a case of bilateral disease of the second and third proximal epiphyses of the foot, the findings being interpreted as an epiphysitis.

Case D551. A boy, three and a half years old, was seen in the Out-Patient Department of the Hospital for

Joint Diseases on January 12, 1932, because of pain of a year's duration, in both forefeet. There was no previous illness and no history of injury. Pain was greater in the left foot. Both feet showed moderate valgus with adduction of the forefeet. Motions of the feet were free and painless. No tenderness was present over the bases of the metatarsals and only slight tenderness beneath their heads.

Roentgenograms of both feet were taken and revealed these interesting changes.

Proximal or pseudo-metatarsal epiphyses were noted at the bases of the second, third, and fourth metatarsals, bilaterally. The epiphysis of the base of the



FIG. 1

\* From the Service of Dr. Leo Mayer, the Hospital for Joint Diseases, New York.

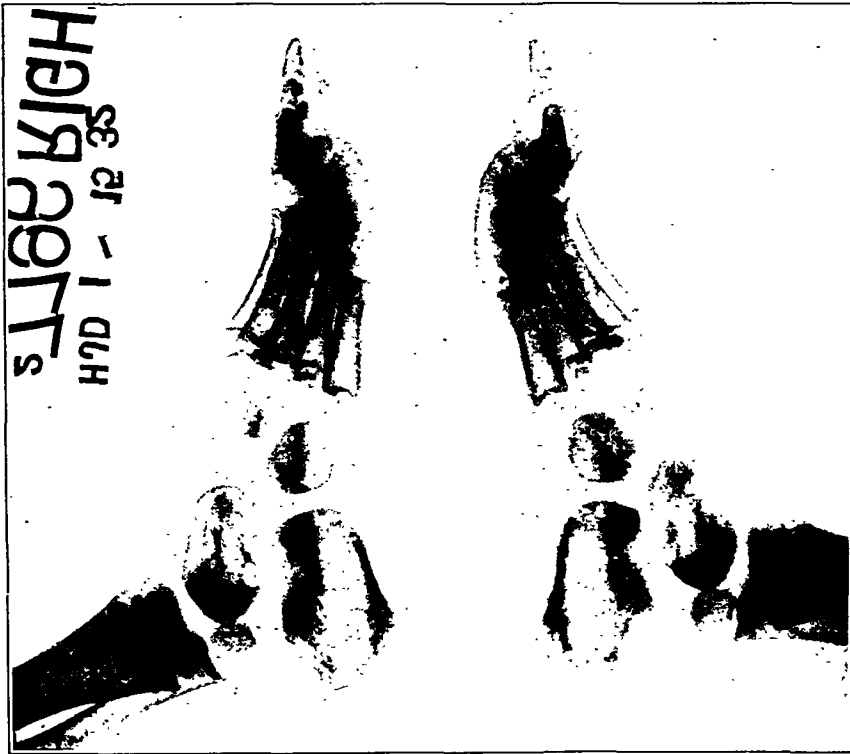


FIG. 2

fourth metatarsal was well developed and normal on both sides. No proximal epiphyses were seen in connection with the fifth metatarsals. The accessory epiphyses over the second and third metatarsals were indistinct, swollen, fragmented, and showed indefinite areas of rarefaction and condensation. These changes were best seen in the proximal epiphysis of the second metatarsal, better on the right side. The normal distal epiphyses of the metatarsals were well seen at the head of the second metatarsal bone on both sides. The third, fourth, and fifth metatarsal heads on the right foot did not show distal epiphyses. The third and fourth left metatarsal heads presented indistinct distal epiphyses.

The proximal epiphysis of the first phalanx of the great toe appeared slightly compressed anteroposteriorly and possibly denser than normal, on both sides. It is doubtful if this epiphysis is the seat of an aseptic necrosis. The centers of ossification of the navicular bones were not present and the cuneiform bones showed beginning ossification. Greatest ossification was present in the external cuneiform of the right foot, which showed two areas of increased density in its substance.

The patient was seen only twice and could not be located for further examination.

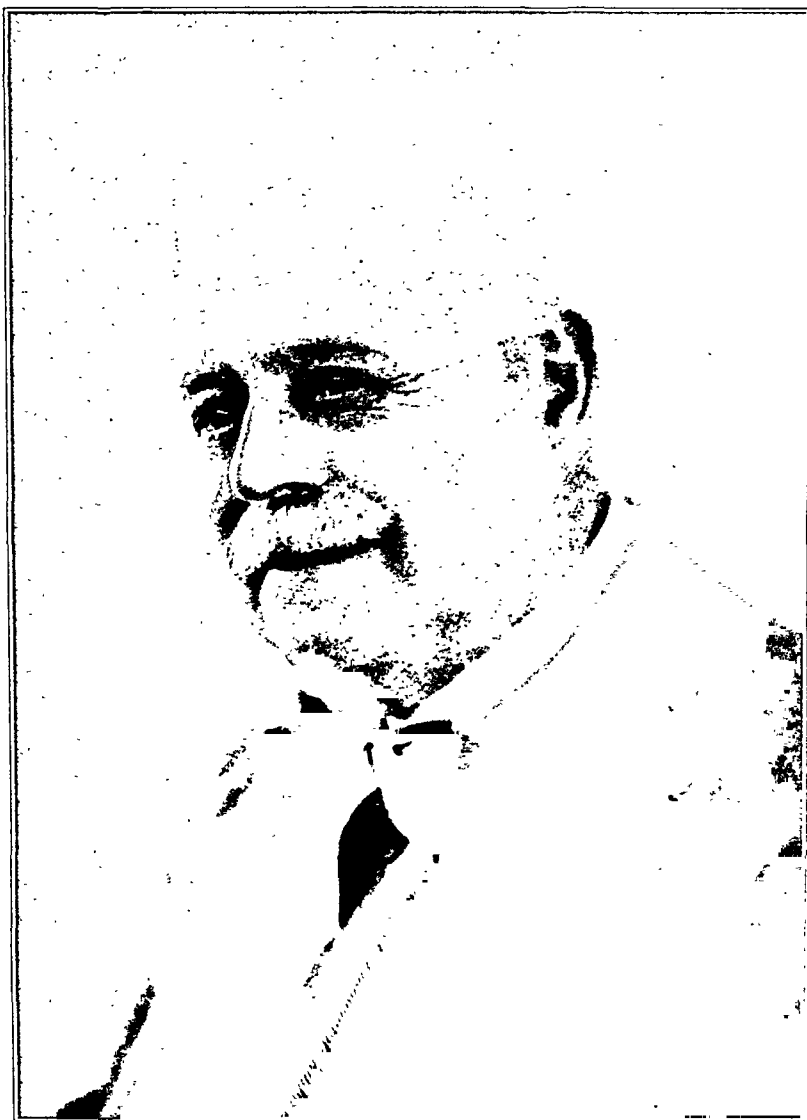
This change is most probably of a self-limited nature, and, if x-ray examination is carried out after the age of five and a half years, it will probably have cleared up, since this is the upper age limit of irregularities of ossification in the feet of normal children. Its roentgenographic features correspond to those usually attributed to epiphysitis. Again, this is an unusual location for epiphysitis.

May I express my thanks to Dr. M. Pomeranz for his aid and criticism of this paper.



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SIR ROBERT JONES

**SIR ROBERT JONES, BT. K.B.E., C.B., F.R.C.S.**

The kindly word, the cheering smile, the twinkling eye, the whole magnetic personality of Sir Robert Jones remains only as a memory. The world's greatest orthopaedic surgeon has completed his life's work; quietly as he was born seventy-four years ago at Rhyl on the North Wales coast, just as quietly he died in the early days of this year at a little village in Montgomeryshire.

In an appreciation of the life of a great man it is customary to refer to the loss the world has sustained in his death. But by his very greatness Sir Robert Jones has mini-

mized this loss; as long as Orthopaedic Surgery lives, so long lives his spirit. He it was who allied the pioneer work of his uncle, Hugh Owen Thomas, with the principles of modern aseptic technique, who differentiated the surgery of the spine and limbs from other branches of Medicine, who fought for the recognition of Orthopaedic Surgery, who with infinite tact and perseverance struggled to establish it on a firm foundation, and who had the satisfaction during his lifetime of observing the progress and the development of his offspring. He whose work cannot die, whose influence lives on after him, whose disciples can perpetuate and multiply his gifts to humanity, is truly immortal.

Hugh Owen Thomas was the descendant of many generations of unqualified bone-setters who had practised in the hills of Wales. Hereditary skill and dexterity were coupled with academic training and enriched with the products of an original and fertile mind. His patients were drawn not only from the industrial centers of Liverpool but from far beyond the boundaries of his own country, to the house in Nelson Street which is now world famous. Here it was that Robert Jones served his early apprenticeship and learned principles of treatment which frequently were uncompromisingly antagonistic to the accepted teachings of the day. Here he continued to work throughout his life, and in the same small cubicles he was still seeing patients until within a few weeks of his death.

He qualified in 1878 and obtained the F.R.C.S. Ed. in 1889. As a very young man, he was appointed General Surgeon to the Liverpool Stanley Hospital, and when thirty years of age continued general surgery at the Royal Southern Hospital. Ultimately he confined his activities to orthopaedic surgery and with abounding energy and unquenchable zeal he would complete twenty or more operations in an afternoon. He was visited by surgeons from all over the world, not only at the Southern Hospital but at his free Sunday clinics at Nelson Street. The majority of visitors, like the Mayo brothers in their earliest European tour, intended staying for a day, but found themselves magnetized for a week. He influenced the development of orthopaedic surgery not only through his visitors but through his patients, and many have themselves become distinguished in the annals of orthopaedics. His early association with Dame Agnes Hunt led to the development of a hospital first at Baschurch and later at Gobowen, which has since organized the treatment of cripples over a hundred miles' radius and has proved the forerunner of the orthopaedic after-care clinics established throughout England and Wales. Any attempt to enumerate his hospital appointments—Heswall, Chailey, St. Vincent's, Llangwyffan, St. Thomas', Shepherd's Bush, Roehampton, and so on—simply points to the fact that there has been no orthopaedic center in England which has not been served by him.

Behind his genial, smiling countenance and apparent simplicity, Robert Jones possessed the keenest brain, the most brilliant organizing ability, and the tact, the patience, the perseverance and the astuteness of a diplomat. Never was man faced with greater difficulty or with more serious opposition than he was in the early days of the War, when he was entrusted with the establishment of the first military orthopaedic service of this or any other country. He was appointed to the war office as Director of Orthopaedics with the rank of Hon. Major General. England's home service began with 200 beds at Alder Hey in Liverpool; but within a short time the help of many English and American surgeons was enlisted, and 33,000 beds were equipped and staffed with trained orthopaedic surgeons. The brain which had already solved the problems of the cripple in civil life readily adapted itself to the problems of war. Incredible as it may be, the gigantic task was accomplished and a complete service established from first aid treatment in the field to the last stages of re-education and after-care. In 1918 he continued and completed his military orthopaedic work through his appointment as Hon. Consultant to the Ministry of Pensions. In recognition of his war services, His Majesty conferred upon him the C.B. and later a knighthood, and the United States Army awarded him the Distinguished Service Medal.

The academic world found it difficult to pay adequate tribute and honor to the name of Sir Robert Jones. There appears to be no important orthopaedic congress over which he has not at one time presided. Having already been the first president of the Interna-

tional Orthopaedic Society, this body expressed its almost inarticulate admiration by appointing him Permanent President. Similarly he was Emeritus President of the British Orthopaedic Association. He was the recipient of honorary degrees of the Universities of Liverpool, Aberdeen, Wales, Yale, Harvard, and Smith College. Honorary fellowships were conferred upon him by American, French, German, and Italian bodies.

Eulogy and laudation were as nothing to Sir Robert when compared with the friendship of his fellow men. He was a most accomplished raconteur but invariably the story was a true one. His sense of humor was of the most vivid type, his memory surprisingly retentive, and nothing pleased him more than to tell a story against himself. Hour after hour he would recall how he had been routed from a tenement house by an irate parent, how in a royal palace he had made a frustrated effort to wash his hands and disturbed a prince in his bath, how travelling in a train and troubled with a painful knee he had been advised to consult a rather good bone-setter in Liverpool by the name of Robert Jones. He was widely read and in his early days founded a literary society in Liverpool. Among his friends he numbered many distinguished authors and artists, as well as lawyers, politicians, judges and actors. He was keenly interested in cricket, an expert boxer, an authority on pedigree dogs, and deeply attached to his St. Bernard and Alsatian. Above all was his love for children who rapidly learned to trust him. He spoke ill of no man, and was utterly incapable of meanness, sarcasm, or unjust criticism. Calm, unruffled, and restrained, his displeasure was felt rather than heard and was the more effective for its rarity.

Throughout his career he practised in Liverpool, and Liverpool has paid its last and greatest tribute to the honor of one of its citizens. The ashes of Sir Robert Jones are the first to find a resting place within the walls of the Cathedral. The urn stands on a column of stone, close to the foundation pillar, beneath the stained glass window dedicated to "Service". As long as the walls of that vast cathedral stand, they will shelter all that has died of Robert Jones, as a token and a memorial of his service to mankind. In the hearts and minds of those who came within the glow of his presence and who learned humbly to love him, his spirit still lives.



ANSEL G. COOK

### ANSEL GRANVILLE COOK

Ansel Granville Cook, son of Captain William and Harriet (Bliss) Cook, was born in Scotland on April 18, 1862, at a time when his father was United States Consul to Scotland. He died suddenly of heart disease at his home, 722 Asylum Avenue, Hartford, Connecticut, on January 25, 1933.

Dr. Cook was graduated from the College of Physicians and Surgeons of Columbia University, New York, in 1887, and followed continuously his profession as orthopaedic surgeon in Hartford, Connecticut. He was Orthopaedic Surgeon, and also Consulting

Surgeon, to the Hartford Hospital, and Consulting Surgeon to several other important hospitals in the State. He was a Charter Member of the American Orthopaedic Association and served as President in 1909, and was always present at the meetings of the Association. In 1926, the honorary degree of Doctor of Science was conferred on him by Trinity College. He was elected an Honorary Member of the American Academy of Orthopaedic Surgeons, which was organized in January 1933.

He had many and wide interests and his mind was fertile, and he was constantly occupied in initiating new methods and designing mechanical means of treatment. His capacity to think along fundamental lines, to think clearly, logically, courageously, and honestly, coupled with his great ingenuity and resourcefulness, naturally led him to conclusions of importance in the rapidly changing medical world in which he lived. Especially should his work on the foot and the shoes and his exhaustive study of what he called "Question of Balance" have special mention. They were both original and practical. His article on "Tuberculosis" and "The Mind Cure" clearly shows his broad grasp of psychology years before the subject was a household word. His practical plan for the treatment of rickets long before vitamins were known, cannot be improved upon today since it embodied the principles of rest, sunshine, fresh air, and natural clean milk which was not to be "sterilized, pasteurized, nor devitalized" in any way.

Dr. Cook was among the first of the orthopaedic surgeons of the Medical Reserve Corps to ask for service in 1917. He said to the Director of the Orthopaedic Service in the Surgeon General's Office: "I have closed my office, and told my patients that I will not be back until the War is over. I ask for immediate service." He served as Major and for a short time was stationed at Fort Adams, Newport, Rhode Island, and then sent as instructor and inspector to a group of army posts in the eastern part of the South, and from there to Fort Sam Houston, Texas, where he remained until the end of the War. He gave throughout generously not only of his skill, but also of his unusual personality.

From a letter signed "E. C." from Santa Barbara, California, published in the Hartford Daily Courant of February 3, 1933, the following is taken:

"We shall miss his presence among us, the brave gentle soul who met life with such valiant courage. I think of him in so many ways: the great surgeon with the gift of healing and restoring in his sensitive fingers; the friend whose joy it was to do kind things for people; the lover of birds and animals and all the beneficent, wise ways of nature; the affectionate father whose greatest joy was the happiness and success of his children; the inventor who loved to create things with mind and hands.

"I recall the quaint, original humor that was so uniquely his own, and the child-like quality of his nature, which was almost too sensitive for the thorns of this world, the absolute sincerity and simplicity of his soul, and the heroism with which he bore great physical pain.

"I am sure that many homes are happier today because he lived, for to him it was given to make the lame walk, to straighten the crippled body. In his modest, unassuming way he often said, 'I have done the best I could. If I had known better, I would have done better.' He followed the light as he saw it."

He was a loved member of the American Orthopaedic Association, and no annual banquet was ever quite perfect without an after-dinner speech by him. He was a shy man, and droll; proud of his children, and considerate. A close friend paid him tribute when he said, "He and Robert Jones were the two most lovable men I have ever known."



ROBERT SOUTTER

### ROBERT SOUTTER

*Dr. Robert Soutter died very suddenly in Boston on February 21, 1933, as the result of an infection incurred during an operation. His sudden death in the prime of his prominence as an orthopaedic surgeon leaves a place which is difficult to fill.*

Dr. Soutter was born in Kingston, New York, October 4, 1870. His antecedents for several generations belonged to the South. His early and impressionable years were spent in France where he obtained a lasting interest in the French people and the French customs and a thorough knowledge of the French language. Thus, he was in later life

able to be a charming and interesting host to all our French visitors, among whom he had many loyal friends.

He was graduated from Harvard Medical School in 1898 and served as an interne at the Boston City Hospital and at the Children's Hospital, in both of which hospitals he left an enviable reputation for his gentleness and loyalty and the meticulous care which he showed always in later life in all his dealings.

Dr. Soutter identified himself from the beginning with orthopaedic surgery which he practised during his entire career and served in his professional capacity in many institutions, among which were the Boston Dispensary, the House of the Good Samaritan, and the Peabody Home for Crippled Children. For thirty years he was Orthopaedic Surgeon to the Children's Hospital and a member of the orthopaedic teaching staff of Harvard University. He was a member of the Board of Trustees of the Massachusetts Hospital School for Crippled Children at Canton, and was also connected with the Long Island Hospital as Chairman of the Executive Board, and rendered great service in making this institution one of the best of its kind in America.

He was a member of the American Orthopaedic Association and was Vice-President of the Association at the time of his death. He was also a member of the Interurban Orthopaedic Society in which he was particularly interested and whose members he numbered among his closest friends; also a Fellow of the Société des Chirurgiens de Paris and a member of the International Orthopaedic Society.

Starting his career in the early days of orthopaedic surgery, he used the opportunities which were presented to the full and made valuable contributions toward the enrichment of his chosen specialty. He contributed many articles dealing with the problems of orthopaedic surgery, particularly congenital dislocation of the hip, and was the author of a volume of orthopaedic surgery. Carefulness and good judgment marked his work in the surgical field, and the results of his operations testified to these qualities.

Aside from his ability as a surgeon, he understood the practice of medicine as few others. His singleness of purpose and deep devotion to his family and profession marked his whole life. He was always tactful, patient, thorough, and sympathetic. Naturally retiring and sensitive, he was always thoughtful and careful of the feelings of others. He was indeed a great physician and a true gentleman.

Robert Louis Stevenson came very near to Dr. Soutter when he said, "Generosity he has, such as is possible to those who practice an art, never to those who drive a trade; discretion, tested by a hundred secrets; tact, tried in a thousand embarrassments; and what are more important, Heracleian cheerfulness and courage. So it is that he brings air and cheer into the sickroom, and often enough, though not so often as he wishes, brings healing."



# News Notes

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Just as *The Journal* goes to press, word has been received of the sudden death on March 22 of Edward A. Rich, M.D., of Tacoma, Washington. Dr. Rich was always interested in *The Journal* and, since 1926, had served as a member of its Advisory Editorial Staff.

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**The Forty-Seventh Annual Meeting of the American Orthopaedic Association** will be held in Washington on May 8, 9, 10, and 11, as a part of the American Congress of Physicians and Surgeons. The headquarters of the American Orthopaedic Association will be the Mayflower Hotel. The scientific sessions and clinical presentations will be held at the Walter Reed Medical Center, and transportation will be provided from the Hotel to the Center.

There will be a general meeting of the American Congress of Physicians and Surgeons on Tuesday afternoon, May 9, and the President of the Congress will hold a reception on the evening of Wednesday, May 10.

The tentative program for the Meeting of the American Orthopaedic Association, as prepared by the Program Committee, is as follows:

## MONDAY, MAY 8

### *Morning Session*

Roentgenographic Studies of Parathyroid Deossification (slides)	Major J. J. Moore, Washington
End Results of Reconstruction Operation in the Hip (slides and patients)	F. M. Hand, M.D., Washington
The Treatment of Fractures Involving Joints (slides and patients)	Major H. W. Kinderman, Washington
Melorheostosis Leri: Report of Case (slides)	Major J. J. Moore, Washington
The Tunnel Skin Graft as Applied to Orthopaedic Surgery (slides)	Colonel W. L. Keller, Washington
Operative Correction for Non-Union and Mal-Union (slides and patients)	Major N. T. Kirk, Washington
End Results of Fractures of Neck of the Femur (slides and patients)	G. W. Leadbetter, M.D., Washington
Exhibit of Bone Tumors, Gross, Microscopic and X-Ray	Major R. O. Dart, Washington
Exhibit of Army Methods of Splinting Fractures of Long Bones for Transportation	Major V. H. Cornell, Washington
Luncheon—Walter Reed General Hospital	Major H. W. Kinderman, Washington

### *Afternoon*

Inspection of Departments, Walter Reed General Hospital  
Golf, Army and Navy Country Club

### *Evening*

President's reception to members by Dr. Steindler and Mrs. Steindler

## TUESDAY, MAY 9

*Morning Session*

Chronic Osteomyelitis Presenting Distinct Tumor Formation Simulating Clinically True Osteogenic Sarcoma (slides)

Backache

Dupuytren's Contracture (slides)

Simple Method of Treatment on Many Metatarsal Disabilities (slides)

Sciatic and Sacro-Iliac Disease

Prespondylolisthesis: Its Roentgenographic Appearance and Clinical Significance

Acute and Chronic Forms of Bursitis (drawings to illustrate)

Association Business Meeting

Luncheon, Walter Reed General Hospital

George R. Elliott, M.D., New York

Joel E. Goldthwait, M.D., Boston

Henry W. Meyerding, M.D., Rochester, Minn.

J. T. Rugh, M.D., Philadelphia

Albert Freiberg, M.D., Cincinnati

S. Kleinberg, M.D., New York

Charles E. Sevier, M.D., Denver

*Afternoon*

General Assembly American Congress of Physicians

*Evening*

Annual Banquet of the American Orthopaedic Association—Mayflower Hotel

## WEDNESDAY, MAY 10

*Morning Session*

Is There a Rational Treatment of Polyarthrititis?

A New Operation for Recurrent Dislocation of the Jaw

Chronic Synovitis of the Knee with Persistent or Recurring Effusion, and of Undetermined Etiology

The Treatment of Acute Purulent Arthritis by Joint Washing and Closure  
Surgery of Painful Arthritis of the Hip in the Elderly (slides)

Fusion of Tuberculous Hips

Original Features in Arthroplasty to Mobilize Joints

Report on End Results of the Tuberculous Joint

P. W. Nathan, M.D., New York

Leo Mayer, M.D., New York

A. Bruce Gill, M.D., Philadelphia

Theodore E. Orr, M.D., Philadelphia

Hugh T. Jones, M.D., Los Angeles

M. S. Henderson, M.D., Rochester, Minn.

R. I. Harris, M.B., Toronto

Fred H. Albee, M.D., New York

Z. B. Adams, M.D., Boston

*Luncheon**Afternoon Session*

Presidential Address

The Relation of Blood Chemistry to the Locomotor System

Block Osteotomy for Bowed Femur

Tendon Transplantations in the Upper Extremity in Cases of Poliomyelitis

Mechanical Instability of the Shoulder Joint: In Relation to Prevention and Treatment of Painful Shoulders

Arthur Steindler, M.D., Iowa City

Russell M. Wilder, M.D., Rochester, Minn.

Edwin W. Ryerson, M.D., Chicago

Frank R. Ober, M.D., Boston

Lloyd T. Brown, M.D., Boston

John J. Kuhns, M.D., Boston

Description of Operative Procedure for  
Improvement of Cases with Quadri-  
ceps Paralysis

C. C. Yount, M.D., Philadelphia

Pelvic Relaxation During Pregnancy

Philip D. Wilson, M.D., Boston

Transplantation of Astragalus and Car-  
pal Navicular Bone

{ D. B. Phemister, M.D., Chicago  
William S. Keith, M.D., Chicago

A New Method of Osteotomy for Cor-  
rection of Long Standing Bony De-  
formity at the Knee

Armitage Whitman, M.D., New York

A Study of Torsional Deformity of the  
Lower Extremity with Special Regard  
to Etiology and Clinical Significance

I. William Nachlas, M.D., Baltimore

#### *Evening*

Private Dinners

Reception by President of the American Congress of Physicians

#### THURSDAY, MAY 11

#### *Morning Session*

Nerve Injuries Associated with Frac-  
tures

Dean Lewis, M.D., Baltimore

Complicated Contractures of the Hand;  
Their Treatment by Freeing Fibrosed  
Tendons and Replacing Destroyed  
Tendons with Grafts

S. L. Koch, M.D., Chicago

Knee Joint Instability and Crucial  
Ligament Injury

Arthur Krida, M.D., New York

Fractures of the Condyles of the Hu-  
merus

J. S. Speed, M.D., Memphis

Fracture of the Ulna with Dislocation  
of the Head of the Radius

Samuel R. Cunningham, M.D., Oklahoma  
City

Treatment of Fracture of the Tibia and  
Fibula: Kirschner Wire Method

C. F. Eikenbary, M.D., Seattle

Data on Fracture Healing: Series of  
2000 Rats

Merrill K. Lindsay, M.D., New Haven

#### *Noon*

Executive Session of the Association

Presentation of Certificates to New Members

The organization meeting of the **American Academy of Orthopaedic Surgeons** was held in conjunction with the Clinical Orthopaedic Society in Chicago on January 12, 13, and 14, 1933, Dr. E. W. Ryerson acting as President and Dr. W. C. Campbell as Secretary.

On January 11 preliminary meetings of the Executive Committee were held in which the organization was discussed and committees appointed.

The clinical meetings were held in conjunction with the Clinical Orthopaedic Society and on Thursday, January 12, the following program was given by the American Academy of Orthopaedic Surgeons at the Thorne Memorial Auditorium of the Northwestern University Medical School:

#### *Morning Session*

Call to Order

President, E. W. Ryerson, M.D., Chicago

Embryology of Bones and Joints

Prof. L. B. Arey, M.D., Chicago

Bone Pathology	{ Prof. F. R. Zeit, M.D., Chicago
	{ Prof. J. P. Simonds, M.D., Chicago
Symposium on Parathyroidism	{ M. Ballin, M.D., Detroit
	{ P. F. Morse, M.D., Detroit
Address of Welcome	Dean I. S. Cutter, M.D., Chicago
Brief History of Orthopaedic Surgery	Dean I. S. Cutter, M.D., Chicago
Symposium on Neurological Surgery	
Diagnosis of Spinal Cord Tumors	H. W. Woltman, M.D., Rochester, Minn.
Operative Treatment of Spinal Cord Tumors	A. Verbruggen, M.D., Rochester, Minn.
Diagnosis of Peripheral Nerve Lesions	L. J. Pollock, M.D., Chicago
Peripheral Nerve Surgery	A. W. Adson, M.D., Rochester, Minn.
The So Called Brachial and Sciatic Neuritis	L. J. Pollock, M.D., Chicago
Chordotomy	E. Oldberg, M.D., Evanston
Symposium on Circulatory Disturbances of Extremities	{ G. DeTakats, M.D., Chicago
	{ R. W. McNealy, M.D., Chicago
	{ A. W. Adson, M.D., Rochester, Minn.
	{ J. T. Case, M.D., Chicago
Living Fascial Suture	{ W. E. Gallie, M.D., Toronto
Methods of Attaching Tendons to Bones	
Reports of Committees	

*Afternoon Session*

Symposium on Arthritis	J. A. Key, M.D., St. Louis
Experimental Arthritis	P. S. Hench, M.D., Rochester, Minn.
Medical Treatment	{ M. Wetherby, M.D., Minneapolis
Vaccine Treatment	{ J. A. Freiberg, M.D., Cincinnati
Operations on Sympathetic Nerves	A. W. Adson, M.D., Rochester, Minn.
Arthroplasty	W. C. Campbell, M.D., Memphis
Treatment of Gonorrhoeal Arthritis	H. L. Kretschmer, M.D., Chicago
Symposium on Low Back Pain	
Differential Diagnosis	F. J. Gaenslen, M.D., Milwaukee
Treatment	E. W. Ryerson, M.D., Chicago
Demonstration of Manipulative Treatment	H. H. Cox, M.D., Chicago
Surgery of the Spine	
Fractures	E. W. Ryerson, M.D., Chicago
Spinal Cord Tumors	A. W. Adson, M.D., Rochester, Minn.
Surgery of the Hip	{ M. S. Henderson, M.D., Rochester, Minn.
	{ F. D. Dickson, M.D., Kansas City
Reconstruction Surgery of Upper Extremity	A. Steindler, M.D., Iowa City
Surgery of the Hand	S. L. Koch, M.D., Chicago
Stabilization Operations on the Foot	{ W. C. Campbell, M.D., Memphis
	{ E. W. Ryerson, M.D., Chicago
Treatment of Osteomyelitis	H. W. Orr, M.D., Lincoln, Neb.
	S. K. Livingston, M.D., Hines, Ill.
Physical Therapy in Orthopaedic Surgery	J. S. Coulter, M.D., Chicago

*Evening Session at Lake Shore Athletic Club*

Meeting of the American Academy of  
Orthopaedic Surgeons  
Dinner

Moving Pictures Demonstrating the

Galeazzi Treatment of Scoliosis

Philip Lewin, M.D., Chicago

The Chicago Century of Progress

E. J. Carey, M.D., Chicago

On Friday and Saturday, January 13 and 14, the Academy participated with the Clinical Orthopaedic Society in their scientific and clinical program.

The officers of the American Academy of Orthopaedic Surgeons elected for the ensuing year are:

President: Willis C. Campbell, M.D., Memphis

Vice-President: Philip D. Wilson, M.D., Boston

Secretary: Philip Lewin, M.D., Chicago

Treasurer: E. B. Mumford, M.D., Indianapolis

Executive Committee: { F. D. Dickson, M.D., Kansas City  
S. Kleinberg, M.D., New York  
M. S. Henderson, M.D., Rochester, Minn.  
E. W. Ryerson, M.D., Chicago  
John C. Wilson, M.D., Los Angeles  
Philip D. Wilson, M.D., Boston

Membership Committee: { H. W. Meyerding, M.D., Rochester, Minn.  
E. B. Mumford, M.D., Indianapolis  
Maynard Harding, M.D., San Diego  
George E. Bennett, M.D., Baltimore  
Frank R. Ober, M.D., Boston

It was decided that there should be four types of members,—Fellows, Associate Fellows, Honorary Members, and Corresponding Members.

The second meeting of this Academy will be held in Chicago in January 1934; it will be a three-day meeting,—with three mornings of papers and three afternoons of clinical demonstrations.

At the meeting of the **Chicago Orthopaedic Club** held on February 10, Dr. Kellogg Speed presented a Clinico-Pathological Study of Fracture of Neck of Femur, and Dr. Maurice A. Bernstein led a discussion on Bone Tumors.

At this meeting the following officers were elected for the ensuing year:

President: Robert Ritter, M.D.

Vice-President: Jacob Meyers, M.D.

Secretary and Treasurer: Daniel H. Levinthal, M.D.

The Manual of Surgical Sutures and Ligatures, which has been prepared by Davis & Geck, gives very practical information in regard to the manufacture and use of sutures, as well as of the many kinds of sutures and the choice to be made in the various departments of work. Such information will be of practical aid to the surgeon. The various types of sutures and their preparation are described, with directions and rules for their use, and the information is presented in very concise form, easily available. The booklet will be found to be of definite aid to the medical profession in general, and is distributed free to members of the profession, nurses, and students on application to Davis & Geck, Inc., 221 Duffield Street, Brooklyn, N. Y.

The First Joint Congress of the Yugoslavian and Czechoslovakian Orthopaedic Societies met in Zagreb on October 3 and 4, 1932. Prof. Božidar Špišić, President of the Yugoslavian Society, opened the Congress with an address on The Importance of Orthopaedic Surgery in Social Medicine, paying special attention to the subject of the cripple and his position in the social and economic life of the community.

The morning of the first day of the Congress was devoted to the consideration of Tuberculosis of Bones and Joints in its various aspects. The special phases of this subject which were considered were the individual and the social treatment: operation, both as regards time and choice; periarticular arthrodesis, and the indication for surgical treatment; tuberculosis in other organs in cases of bone and joint involvement; choice of employment for tuberculous patients; the need of and results of periodical investigations of the blood composition; results of treatment in hospitals. The large experience which it is possible for surgeons in this community to have with this disease makes such a report particularly valuable.

At the afternoon session the main subject was Rickets, with special reference to the cure of its deformities. The national and social significance of late rickets and of the orthopaedic deformities in those of mature age was discussed by members of both Societies.

The subjects of Scoliosis Deformities as a Sign of Degeneration on the Croatian Coast, Poliomyelitis and the Cure of Paralysis, The Treatment and Classification of the Gastro-Intestinal Symptoms during Poliomyelitis, and Roentgen Therapy for Acute Poliomyelitis were also discussed.

The sessions on the following day were devoted to the presentation of shorter papers and discussion by different members of the two Societies.

The Twenty-Third Congress of the Italian Orthopaedic Society was held in Bologna on October 15, 16, and 17, under the presidency of Prof. Putti. The principal subject for discussion was Congenital Dislocation of the Hip. Prof. Putti pointed out that almost 4000 cases among over 9000 or 10,000 observations were being reported at the Congress, as well as the treatment and observations by the various surgeons.

In his opinion, a population of 42,000,000 might have 84,000 congenital dislocations of the hip, counting two per thousand population. He emphasized the great importance of the knowledge of the very early symptoms and of the hereditary-familial factors. Twenty-two per cent. of his statistics showed an hereditary etiology. He recommended systematic examination of every new-born child.

A very large number of papers were presented by members of the society and by guests from other countries, among whom were Prof. Spitzky of Vienna, Prof. Zaremba of Crakow, and Prof. Max Lange of Munich.

Prof. A. Annevazzi gave a statistical report on The Late Results of the Bloodless Reduction in Congenital Dislocation of the Hip. Out of over 1327 patients operated upon for congenital dislocation of the hip, 1610 hips were treated by the bloodless method. More than 300 of these were examined. The results in the unilateral cases were as follows:

Operated upon under two years of age: good results in eighty-two per cent., satisfactory in nine and six-tenths per cent., bad in two and seven-tenths per cent., relaxation in five and seven-tenths per cent.

Operated upon from two to five years of age: good results in sixty-six and one-tenth per cent., satisfactory in fourteen and one-tenth per cent., bad in eight and seven-tenths per cent., relaxation in eleven and one-tenth per cent.

Operated upon from five to ten years of age: good results in fifteen and nine-tenths per cent., satisfactory in six and one-tenth per cent., bad in thirty-two and nine-tenths per cent., relaxation in forty-five and one-tenth per cent.

Operated upon over ten years of age: good results in sixteen per cent., satisfactory in nine per cent., bad in thirty-six per cent., relaxation in thirty-nine per cent.

The results of the bloodless treatment in bilateral cases of congenital dislocation of the hip were as follows:

Operated upon under two years of age: good results in forty-nine and five-tenths per cent., satisfactory in thirty-eight per cent., bad in five and three-tenths per cent., relaxation in seven and two-tenths per cent.

Operated upon from two to five years of age: good results in thirty-three per cent., satisfactory in thirty-nine and eight-tenths per cent., bad in twelve per cent., relaxation in fifteen and two-tenths per cent.

Operated upon from five to ten years of age: good results in seventeen and nine-tenths per cent., satisfactory in three and six-tenths per cent., bad in thirty-two and one-tenth per cent., relaxation in forty-six and four-tenths per cent.

When the patients were reexamined, the results in the cases of unilateral dislocation of the hip were as follows:

Seen five years or less after operation: good results in seventy-one per cent., satisfactory in nineteen per cent., bad in two per cent., relaxation in eight per cent.

Seen more than five years after operation: good results in sixty-one per cent., satisfactory in eight per cent., bad in fourteen per cent., relaxation in seventeen per cent.

The results in cases of bilateral dislocation of the hip were as follows:

Seen more than five years after operation: good results in thirty-nine per cent., satisfactory in thirty per cent., bad in fourteen per cent., relaxation in seventeen per cent.

It appears from these statistics that while the good results seem fairly permanent, this is not true with the bad results which are considerably increased as time goes on at the expense of the satisfactory results which are at first rather numerous, thirty and twenty-five per cent., gradually diminish to seventeen and eleven per cent. (unilateral and bilateral), and finally drop to as low as five and six-tenths per cent. twelve years after reduction.

The remainder of the session was given over to the separate reports on various interesting orthopaedic subjects.

### ROBERT JONES MEMORIAL APPEAL

The death of Sir Robert Jones, of Liverpool, has taken from us one of the most distinguished of English surgeons, the creator of modern orthopaedic surgery, and the founder of the British School of Orthopaedics.

Many of his colleagues, patients, and friends feel that a last tribute should be paid to his memory in recognition of his services to the cause of surgery, and to multitudes of patients, and to recall his service to the Army during the Great War.

Sir Robert Jones was regarded throughout the world as the greatest orthopaedic surgeon of all time; and it is only fitting that his supreme merit should be recognized in this way, and that his example should constantly be brought to mind as an incentive and encouragement to those who come after.

It is hoped to be able to arrange to include in our benefactions Liverpool, the Royal College of Surgeons of England, and perhaps other bodies with which he was associated if, as we feel sure will be the case, an adequate sum of money is received in response to this appeal.

Signed by:

Derby, Chancellor of Liverpool University, Secretary of State  
for War 1916-18, and 1922-24

Arthur Stanley, Chairman, British Red Cross Society, Treasurer,  
St. Thomas's Hospital

Holburt J. Waring, President, Royal College of Surgeons

Moynihan, Past-President, Royal College of Surgeons, Chairman,  
Army Medical Advisory Board

- E. Farquhar Buzzard, Regius Professor of Medicine, University of Oxford  
 W. Langdon-Brown, Regius Professor of Physic, University of Cambridge  
 J. W. Dowden, President, Royal College of Surgeons, Edinburgh  
 Frank Crawley, President, Royal College of Surgeons, Ireland  
 Harold B. Fawcus, Director-General, Army Medical Services  
 Wicklow, President, Central Council for the Care of Cripples  
 Winifred Portland  
 A. F. London  
 Albert Liverpool  
 H. R. Hurter, President, Liverpool Medical Institution  
 Alfred Gates, Lord Mayor of Liverpool  
 Harold Stiles  
 H. J. W. Hetherington, Vice-Chancellor, Liverpool University  
 R. E. Kelly, Professor of Surgery, University of Liverpool  
 Charles J. Macalister  
 W. I. deC. Wheeler, Past-President, Royal College of Surgeons, Ireland  
 C. Thurstan Holland  
 D. P. D. Wilkie, Professor of Surgery, University of Edinburgh  
 Georgiana Buller, Vice-Chairman, *Executive Committee Central Council for the Care of Cripples*  
 A. G. Hunt  
 W. J. Mayo, Rochester, Minnesota  
 C. H. Mayo, Rochester, Minnesota  
 W. E. Gallie, Toronto, Canada  
 Arthur Steindler, President, American Orthopaedic Association  
 DeForest P. Willard, Secretary, American Orthopaedic Association  
 Willis C. Campbell, President, American Academy of Orthopaedic Surgeons  
 Putti, Bologna  
 Nové-Josserand, President, International Society of Orthopaedic Surgery  
 Murk Jansen  
 H. A. T. Fairbank  
 R. E. Elmslie  
 W. Rowley Bristow  
 G. R. Girdlestone  
 A. S. Blundell Bankart, President, British Orthopaedic Association  
 Harry Platt  
 Naughton Dunn  
 D. McCrae Aitken  
 S. T. Irwin  
 T. P. McMurray

Subscriptions may be sent to Mr. Bankart, 58, Harley Street, London, W.1.

A meeting of Signatories of the Robert Jones Memorial Appeal and others interested in the objects of the Appeal, was held at the House of The Royal Society of Medicine, 1, Wimpole Street, London, W.1, on Thursday, March 9, 1933.

It was decided that all the Signatories should constitute a General Committee for the purposes of the Appeal, and that the following names should be added: Sir Arthur Probyn Jones, Mr. Frederick Watson, Mrs. Kimmins, Dr. E. G. Brackett, Dr. Joel Goldthwait, Dr. R. B. Osgood.

An Appeal Sub-Committee was appointed with power to act and to take such steps as may seem necessary or desirable to raise funds for the Memorial.

It was agreed that the principal object of the national Memorial should be the endowment of Orthopaedic Teaching and Research, but that an endeavor should be made to coordinate local and national interests.



# Current Literature

FINAL REPORT OF THE COMMISSION ON MEDICAL EDUCATION. Privately printed from the office of the Director of Study, 630 West 168th Street, New York City, 1932. Also New York City, Columbia University Press. \$2.00.

This report, the investigations for which were started in 1925 and have been issued at intervals as separate studies, comprises a consideration of the needs of the public in respect to medical service, the number and distribution of physicians, the ratio of this number to the population and their distribution in urban and rural communities, the social and economic factors to be considered in adjusting medical service to present-day requirements, the progress of the medical sciences, the cost of medical education, and the rôle the sciences play in modern medical training, the prevalence of specialization, the causes for it, and many other factors. In summing up their conclusions the Commission recognizes that it is *the quality of care* that is of greatest importance and not the plan of organizing nor the method of financing. Though it urges standardization of practice on a mass production basis it insists that the unit of practice is the individual patient. It urges that training for the modern physician should include instruction in respect to social and economic conditions.

At present there is a numerical oversupply of physicians, but their distribution is faulty and there is too great a preponderance of specialists. Facilities for transportation, public health services, hospital clinics, home nursing, etc., should furnish a sound basis for providing modern medical care for all classes of the public without resorting to artificial programs.

The Commission recommends a Register of properly qualified specialists, and emphasizes the desirability of a non-specialized practice. They stress as a matter of major importance post-graduate teaching at conveniently located hospital centers where the progress of medical study and practice may be brought home to practitioners too busy to go away to procure it. The training of internes should be so revised that they may be prepared for independent practice in localities where all the facilities to be had during their hospital experience may not be available. Such a high percentage of graduates of "A class" schools pass the State registration authorities that the Commission inclines to the view that graduates of high-grade schools be registered without further examination, the State authorities, through inspection of the schools, being satisfied as to the maintenance of standards. Some of the defects in medical education are due to failures in preliminary training in secondary schools and to the kind of premedical subjects taught, some of which have been impracticable and time-wasting. The Commission would postpone specialized subjects to a post-graduate period and would lay more and more emphasis upon developing a resourceful mental equipment which shall make possible a "continuance education". Correlation of subjects is playing an important part in the scheme of training in the schools of today. The Commission urges the significance of preventive medicine in present-day life and advocates wider familiarity with social problems through a better planned general education.

The Commission believes in a more flexible interpretation of qualifications for medical study, laying emphasis upon character, personality, industry, resourcefulness, ability, and scholarly achievement. The particular method of achieving such of these qualifications as are not native to the individual they are not particularly concerned about. Time should be saved in the preparatory years.

In the medical courses due recognition should be given to changing social conditions and improvements in the techniques of investigation, but the really important influences in training for the profession are the personal contacts of able teachers and practitioners with the student in clinical teaching.

The public should demand a trained leadership in medicine, if it is to protect itself

against incompetency and charlatanism, and should not suffer such leadership to become politically or commercially dominated nor be reduced to mediocrity through mass production methods.

There is included in this report, as an appendix and as part of the basis for the conclusions drawn, a discussion of European methods in medical education, and 159 tables covering the topics discussed in the report.

LE GENOU: ANATOMIE CHIRURGICALE ET RADIOGRAPHIQUE CHIRURGIE OPÉRATOIRE. (The Knee: The Surgical and Roentgenographic Anatomy from the Operative Standpoint.) By Antoine Basset. Paris, Masson et Cie, 1932. 45 francs.

In the beginning, the author emphasizes the necessity of thorough familiarity both with the anatomy and with the roentgenographic appearance of this joint. He recognizes and emphasizes the fact that articulations do not lend themselves kindly to operative procedures, and stresses the necessity for great care in all joint operations. One of the requirements for this care is the thorough knowledge of the anatomy and the methods of procedure.

In the first portion of the book, the author describes in detail the anatomy and the x-ray picture, particularly in its relation to operative procedures, and he also indicates carefully and in detail the significance of the roentgenographic findings. A chapter is devoted to the anatomy of the ligaments and the capsule and the application of the special conformation of these structures to their functions, which has its relation to the operative procedures necessary to them. This portion of the book is copiously illustrated by excellent anatomical line drawings and by roentgenograms, and the significance of the x-ray findings is well described.

In the operative portion of the book, all the recognized avenues of approach to the joint cavity are described and illustrated, and the choice of these methods of approach and the portions of the joint that can be best exposed by them are indicated.

In the surgical portion of the book, the subject of arthrotomies, the different types of fracture involving the knee joint, the lesions of the meniscus, and the lesions of the crucial ligaments are considered in detail. The directions for the operative procedures, both methods and technique, for fractures into the joint are described and illustrated. Also are considered the operations for ankylosis, as well as surgery for tuberculous osteoarthritis, and, finally, disarticulations and intra-articular amputations.

It is valuable to have a work confining itself to the conditions of a single joint, especially one as important as the knee joint. The author has shown throughout the book the results of a careful study of the special structures and functions of this joint, as well as the results of a practical experience in dealing with the clinical problems. The necessity of the great care which has been emphasized in this book in the surgical dealing with joints is particularly valuable and apt in these days of somewhat rash operative tendencies.

DIE CHIRURGIE DER WIRBELSÄULE. (The Surgery of the Spine.) By Dr. Ernst Gold. *Neue Deutsche Chirurgie*, LIV. Edited by Geheimrat Prof. H. Küttner. Stuttgart, Ferdinand Enke, 1933. 45.50 marks.

In view of the interest which has been focused on spine lesions in the past few years, a monograph that includes the newer work is a valuable and timely contribution. Dr. Gold has drawn his clinical material from the rich supply at the University Hospital and other clinics in Vienna, as well as from Prof. Rollier's institution, and Dr. Schrader's clinic in Göttingen. Numerous abstracts and quotations from the literature are representative of the best that has been written on spine conditions. They are frankly labeled as supplements to the experience of Dr. Gold and his coworkers and are effective in removing this monograph from the class of one-man books.

An excellent chapter on traumatic lesions includes injuries of the discs and ligaments as well as fractures. The recent work of Böhler and Schnek occupies considerable space.

Davis is mentioned. The debate over the desirability of reducing compressed vertebral fractures is presented from both sides, with a theoretical endorsement of reduction. There is a good classification of types of spine fractures.

The field of inflammatory diseases is wisely arranged to leave out much dead wood. Only a few words of summary are allotted to the much discussed osteo-arthritis, and space is saved for the careful evaluation of Kummell's disease, a discussion of fractures with tetanus, and actinomyces and echinococcus cysts of the spine. Tuberculosis is not overemphasized. Interesting is the typically Austrian condemnation of spine fusion operations in this disease except in a few selected, resistant cases.

Numerous tumors of the spine are presented. Here, as elsewhere in the book, much is lost by poor reproduction of excellent x-ray material. Illustrations of hemangioma, myeloma, and marble bones are good.

Bone lesions of systemic diseases are well represented and there are some excellent examples of congenital abnormalities. The medical man must have a fair background in the field of spine pathology before he can regard this monograph as a primer; but, as a searching study of the unusual, the book is of exceptional value to the orthopaedic and traumatic surgeon.

**MEDICAL CARE FOR THE AMERICAN PEOPLE.** Final Report of the Committee on the Costs of Medical Care. Chicago, Illinois, The University of Chicago Press. \$1.50.

The final report of the Committee on the Cost of Medical Care, issued from the University of Chicago press, represents an attempt to regulate and standardize the practice of medicine, basing such endeavor upon exhaustive surveys of all factors contributing in any way to present-day dissatisfaction over the cost and inadequacy of medical care in certain strata of society. It is in line with other similar standardization attempts which characterize modern civilization, many of which abandon any further discussion as to whether a principle is intrinsically right or wrong, the combatants being carried along by currents of opinion which have caught the popular fancy and appear to be irresistible. The majority report advocates what would amount to taking the practice of medicine out of the hands of the general practitioners, as individuals, to a very large extent, and consigning it to groups, the costs to be met by taxation or insurance or both. The minority report believes the individual general practitioner should continue to be the center of the system with such modernized methods in the conduct of practice as the needs of local communities require and can support.

A factor entering very heavily into the cost of medical care is one to which this report fails to give any consideration,—*viz.*, the disposition, frequently manifested, to subject all patients to the entire gamut of scientific tests where the problem does not justify the procedure. This often means unnecessary hospitalization for the patient and expensive laboratory equipment and technician charges. To avoid the creation of hospital deficits the number of such investigations must be such as to make the service yield a profit. To make service of the sort proposed available for all the people is a tremendously expensive proposition, both in money and ineffectiveness, the cost of which cannot be justified in the results obtained, either to the community or the individual family units. Specialization is overdone and, because it is overdone, so is hospitalization, both of which are costly. If these were curbed effectively, the general practitioner would have less idle time and would be able and willing to dispense his services to a group now hospitalized as "out" or "in-door" patients, to their, and his own, very great advantage, and along with it would come a restoration of the *esprit de corps* of the profession which has been allowed to sadly decline through commercialization. In medicine, as in everything else, the unthinking public has been allowed to believe that because we are in an age of progress, which means that we are in a zone of "trial and error", every new device employed to diagnose or treat disease must be placed at their disposal, either privately or publicly, and of course some one must bear the expense. Unfortunately, the training of the present-day medical student has instilled this idea into the mind of the medical fledgling.

What we need is a survey sufficiently searching to determine what is really worth while and definitely proven, and then only *such* procedures should be released for general use by the profession.

The majority report recognizes the need for reduction in the number of specialists and suggests that a register of those qualified be kept for the benefit of the public. They also urge, as a means of keeping the rural practitioner abreast of the times, an extension service from the medical schools, using suitably equipped local hospitals as the centers for conducting such post-graduate teaching. These two reforms would tend to lessen costs for medical service, divert practice back to the general practitioner where it belongs, and provide the public outside metropolitan centers with the best that medical science has to offer.

HANDBUCH DER GESAMTEN UNFALLHEILKUNDE. II Band. Herausgegeben von Geh. Rat Prof. Dr. Fritz König und Prof. Dr. Georg Magnus, Stuttgart, Ferdinand Enke, 1933.

Volume II of this work is the continuation of the discussion on the relation of industrial injury to disease. Various legal phases of industrial poisoning are elaborated. This is followed by descriptions of the clinical features of chronic poisoning due to inorganic substances, organic substances, and metallic poisons. There is further a discussion of the injurious effects of x-rays in industry.

One chapter is devoted to diseases of muscles, bones, and joints as the results of working with pneumatic apparatus. Under this heading are described and illustrated joint changes of an arthritic nature, necrosis of the carpal lunate, epicondylitis, myositis ossificans, ganglion, and Dupuytren's contracture.

The problem of accident prevention is one which must be overcome by education of the laborer. Under the heading of general principles of treatment there are found numerous references to legal technicalities; indeed the question arises in the reader's mind whether an injured employee is primarily a medical case or a legal case.

It may be said in favor of this work that the subjects are clearly and fully presented, in so far as they portray the relationship between cause and effect of industrial injury. It is, however, to be expected that its usefulness will be limited largely to industrial surgeons of Germany.

THE HISTORY OF DERMATOLOGY. By William Allen Pusey, A.M., M.D., LL.D. Springfield, Illinois, Charles C. Thomas, 1933. \$3.00.

The History of Dermatology by William Allen Pusey is an interesting and well written addition to the history of medicine. Dr. Pusey calls attention to the fact that the earliest records, the Edwin Smith Papyrus and the Ebers Papyrus, are devoted largely to skin diseases (which would naturally from their conspicuousness and discomfort be drawn to man's attention) and that the history of dermatology can be separated from the history of general medicine only since the latter part of the eighteenth century. It is interesting to see how many of the skin diseases known today can be recognized in these earliest scientific treatises and how much attention was paid to cosmetics and cosmetic dermatology. The book discusses Graeco-Roman, Arabian, and mediaeval dermatology, dermatology in early modern Europe, the beginnings of modern clinical dermatology in Europe, and, in the last half, modern dermatology in continental Europe, England, and the United States.

Dr. Pusey treats the subject in the first half of the book in broad outline with an intelligent consideration of all the influences which contemporary culture and economic conditions have had on medicine in general,—a part of the book well worth reading by all. The last portion is occupied by a more detailed account of the work of the outstanding figures in modern dermatology, almost too concisely told if the reader is interested in this specialty. It is a pity that Dr. Pusey's own achievements in this field could not be included. The volume itself is attractively made, with excellent illustrations and contains an Historical Index of Dermatology which is of great value to the student.

**HYGIÈNE DES PUSSES.** (Hygiene of the Foot.) By Prof. Dr. F. Schede. Leipzig, Georg Thieme, 1933. 1.50 marks.

The author offers this article because hygiene of daily living is neglected, and because such fundamentals commanding medical experience are disregarded. Even the orthopaedist, who should be depended upon for giving counsel to the patient in matters upon physical training, is commonly unmindful of the full needs for development of the body. How foot hygiene may be practised and how ultimately the advice of the physician is sought for foot problems, the weak or relaxed foot, and its relationship to one's general physical and mental status, are discussed.

The foot is the stepchild of the body; this, in spite of the unusual patience it evidences as the weight-bearing organ whose burden is an ever increasing one. Only rarely do we openly show the foot; it is kept covered until a local problem requires attention. When some day it makes itself known, usually in the years of maturity, it is with pain, not unbearable, but almost continuous and boring in character.

Our feet are not intended to be ungainly, or to fail us. As organs of prehension endowed with elasticity, strength, and great mobility, it is surprising to realize what strain they endure. The foot should be as expressive as the hand. Races and tribes living close to nature have no foot troubles. As civilization advances the feet become neglected. From childhood it is put in a shoe, which promptly deprives it of the grasping ability of the toes. We go about on unyielding smooth and hardened floors, which encourages muscular weakness with resultant relaxation. Weakness of musculature manifests itself earlier than any other disturbance of the organs.

Hygiene of the foot is easy to realize but difficult to practise. It is a battle against the conventional methods of living. The foot of a child beginning to walk has no arches. This flat foot is not pathological. The healthy foot of the child needs no heavy, stiff shoe, the strong musculature being sufficient for support. To correct faulty foot posture is not sufficient, the first requirement should be the strengthening of the general musculature. Whether the natural forces are sufficient to sustain the foot properly or whether some mechanical measure is necessary, is purely an orthopaedic problem.

Simple relaxation of the foot, disturbances of the circulation, nodular hardening of the leg musculature, and weakening of the foot articulations, are all factors dependent one upon the other, but they may occur concurrently, especially with the adult. Proper massage to legs and feet are most helpful for restoring muscle tone and circulation to the lower extremities, especially the feet. Such massage should only be undertaken by a physician or under his guidance.

The shoe is a necessary evil, although protection against hard surfaces, cold, wet, and uncleanness. A useful supportive shoe can be made to measure with the built-in arch; this type is preferred to the inserted arch plates. Since the recommendation of positive rational changes in the manufacture of shoes is futile, only one bit of advice about shoes remains,—relieve the foot of the shoe as much as possible.

In conclusion there are two series of exercises presented for use in the home. The first set-up has to do with the foot alone; the second, with advice for the adult with foot disturbances.

**THE MEDICAL SECRETARY.** By Minnie Genevieve Morse. New York, The Macmillan Company, 1933. \$1.50.

This is a small book of practical suggestions for anyone intending to assume, without previous training or experience, the position of the doctor's secretary or nurse, and is written by one who has evidently had a very considerable practical experience. Such a position demands attention to many details of varied character, the necessity of which would escape the appreciation of a novice, even though trained to some allied occupation. The duties and routine in a doctor's office are usually the gradual outgrowth of a man's methods and individuality and only experience can give the necessary training and adaptation for the particular position. A quick intuition and common sense are two qualities most helpful and are not found in general too highly developed. This book will

supply a great deal of that information which ordinarily can be acquired only by more or less practical experience. The abbreviations and usual medical terms, which are a new language to the uninitiated, and which are well explained, help the inexperienced beginner who, as well as the more experienced individual, will avail herself of frequent recourse to this book for information.

**A STANDARD CLASSIFIED NOMENCLATURE OF DISEASE.** New York, The Commonwealth Fund Division of Publications, 1933. \$3.50.

As the result of three years of intensive work, the National Conference on Nomenclature of Disease has issued *A Standard Classified Nomenclature of Disease*, edited by the Executive Secretary, Dr. H. B. Logie. The confusion and inaccuracy which has resulted from the lack of uniformity of record has been prolific of misunderstanding and of the obstacles to cooperation. The Conference represents every branch of medicine and surgery, health departments and agencies engrossed in the medical and surgical health problems, and has covered the entire ground. This work has established a uniformity in the whole field of medicine and represents a very marked aid in the work of establishing medicine and surgery on a more scientific basis.

Dr. Leo Mayer of New York was the chairman of the committee which had charge of the orthopaedic section. He is particularly qualified for this task and has devoted a great deal of his time to its accomplishment.

**DIE TODESFÄLLE UND AMPUTATIONEN DES UNFALLKRANKENHAUSES UND DER ARBEITER-UNFALLVERSICHERUNGSANSTALT FÜR WIEN, NIEDERÖSTERREICH UND BURGENLAND IN DEN JAHREN 1926-1930 UNTER BESONDERER BERÜCKSICHTIGUNG DER SEPSIS NACH FRISCHEN OFFENEN VERLETZUNGEN.** (Deaths and Amputations Resulting from Sepsis at the Accident Hospitals of Vienna, 1926 to 1930, inclusive.) By Dr. Walther Ehalt. Berlin, Julius Springer, 1932. 4.20 marks. (Beihefte zur Monatsschrift für Unfallheilkunde und Versicherungsmedizin. Heft 14.)

The intention of this comprehensive report is brought out in its finality. It sums itself up in a discourse from which there is developed the fact that sepsis may be prevented. There is a detailed consideration of the deaths and amputations at the Accident Hospital and the Workingman's Accident Insurance Hospital, of Vienna, for the five-year period 1926 to 1930.

In concluding the subject "Causes of Death" it is brought to forceful attention that many of the injuries were of minor type, wherein sepsis developed because of an error in treatment. Many patients developing this complication continued in their occupation and failed to receive proper hospital care until the condition from their injuries had advanced too far. Hence, the purpose for emphasizing the policy that regardless of the apparent trivial nature of any wound it must be considered as an injury requiring most careful surgical consideration.

In making a study of the deaths it is observed that the cases treated outside of the hospitals resulted in the development of a greater percentage of gas gangrene, sepsis, and tetanus, than those hospitalized. A great many of the deaths from sepsis had developed from only a minor injury. In all of the deaths at the hospitals from sepsis it was possible to learn that some error in treatment previous to admission was the cause.

**THE RELATIONSHIP OF CALCIUM METABOLISM TO DISEASES OF BONE.** David P. Barr. *Am. J. Cancer*, XVI, 1424, Nov. 1932.

The author has assembled available data on the changes in calcium metabolism present in certain radiologically recognizable diseases of bone. Generalized decalcification may be due to deficient diet, hyperactivity of the parathyroid glands, disease, or thyrotoxicosis. These conditions may show approximately normal values for calcium and phosphorus in the serum in spite of a negative calcium balance.

Osteitis fibrosa cystica presents high serum calcium values, while the phosphorus may be much diminished. Calcium excretion in the urine is high, resulting in a negative

balance. These changes are the result of the underlying hyperparathyroidism. Solitary bone cyst on the other hand shows no abnormality of calcium metabolism. The hyperactivity of the parathyroids in cases of multiple myeloma and generalized carcinomatosis appears to be secondary to the processes in the bones.

Further studies are necessary to establish the rôle of calcium metabolism in the diseases characterized by excessive calcification,—namely, Paget's disease, pulmonary osteo-arthritis, and the osteosclerosis of Albers-Schönberg.

In discussion of this paper, J. D. Camp drew attention to two characteristic roentgenographic findings in cases of osteitis fibrosa cystica,—namely, miliary granular changes in the calvarium, and small subperiosteal areas of cortical absorption especially in the long bones.

The paper is illustrated with roentgenograms characteristic of the various conditions described.—*Grantley W. Taylor, M.D., Boston, Massachusetts.*

**METASTATIC MALIGNANT LESIONS IN BONE.** Charles G. Sutherland, Fred H. Decker, and Earl I. L. Cilley. *Am. J. Cancer*, XVI, 1457, Nov. 1932.

The authors have analyzed the experience of the Mayo Clinic with metastatic malignant lesions in bone, comprising 1032 cases with involvement of 1569 regions. They summarize the evidence for dissemination by lymphatics and by blood stream and conclude that both types of spread are implicated in bone metastases. Metastases occur most frequently where red bone marrow persists, and they may be osteoclastic or osteoplastic. The nature of the metastatic process is dependent on the seat of the primary tumor, its degree of malignancy, and its rate of growth. Tables are given showing the age distribution of the cases involved, as well as the situation of the bone metastases in relation to the site of the primary lesion. The breast and prostate were the commonest sites of origin, accounting for over half the total cases, and for over two-thirds of the total lesions involved.

*Carcinoma of the Breast*—Bone metastasis probably takes place in over fifty per cent. of cases of cancer of the breast. The lesion is almost invariably osteoclastic. The metastases were commonest in the pelvis, although the lumbar spine and ribs also showed a high incidence.

*Carcinoma of the Prostate*—Estimates of the incidence of bone metastasis in cases of carcinoma of the prostate range from thirty to seventy per cent. Here again the pelvis accounts for more than half of the metastases of prostatic carcinoma, although the lumbar spine, femora, and ribs also show frequent involvement. These metastases are predominantly osteoplastic.

*Tumors of the Kidney*—Hypernephroma presents metastasis to the bone in about five per cent. of cases. Fifty-one cases are included in this series, with involvement of seventy-four regions. The metastases are osteoclastic, tend to be fewer in number, and cause marked local destruction, often complicated by pathological fracture. Although pelvis and spine show involvement most often, numerous other regions are frequently implicated.

The authors continue their analysis with discussion of the other types of primary carcinoma, less frequently involving bone metastases, such as uterus and ovary, stomach and intestines, thyroid, bladder, etc. Of interest are several bone metastases from epithelioma of the skin, especially of the extremities. It is also interesting that although there are a few cases deriving from the tonsil, larynx and pharynx, there are essentially none derived from the buccal mucosa, lip, or accessory sinuses.

The article concludes with a satisfactory discussion of the differential diagnosis of the lesions.—*Grantley W. Taylor, M.D., Boston, Massachusetts.*

**A STUDY OF THE HIP JOINT FROM THE STANDPOINT OF THE ROENTGENOLOGIST.** L. B. Morrison. *Amer. J. Roentgenology*, XXVIII, 484, Oct. 1932.

This is a comprehensive review and x-ray study of the hip joint which includes the acetabulum, the anterior inferior spine of the ilium, the articular head of the femur, the

neck and the major and minor trochanters, because certain lesions arising in relation to these are significant.

The characteristics of the adult hip are reviewed as well as the theories of congenital hip dislocations. The author points out that the acetabular defect must be attributed to failure of the secondary genetic center to develop. Therefore, we should not infer that the acetabulum deepens to any extent when once a hip has been reduced. Acetabular development will depend upon the potential power of growth retained in the genetic center. Pressure of the head (reduced) may indirectly stimulate this center.

The early congenital hip can be diagnosed by the following changes,—long and shallow sockets, the portion of the acetabulum above the epiphysis is slightly elongated and more shallow, the femoral head lies above the level of the Y cartilage.

The author concludes that the accessory acetabular rim epiphysis, with its genetic center, is the foundation upon which our knowledge of congenital hip and other anomalies of the hip should be based.—*J. Kulowski, M.D., Iowa City, Iowa.*

NOTE.—This article was one to which Dr. Morrison had given a great deal of time and study. Unfortunately, it was his last contribution to the medical literature because of his untimely death on January 16, 1933.—*Editor.*

#### RECONSTRUCTION-ARTHROPLASTY OPERATION FOR THE HIP. Samuel Kleinberg. *Am. J. Surg.*, XVIII, 64, 1932.

The author describes an operation for reconstruction of the hip which is well conceived, practical, and a distinct advance in the treatment of the type of hip for which the ordinary reconstruction operation has been done.

The operation consists of an osteotomy in the vicinity of the joint line and dislocation of the upper extremity of the femur which was then remodeled into a head and neck, the acetabulum having been cleaned out and enlarged by a reamer. Arthroplasty is then done after the manner of Campbell.

The advantages claimed for the operation are:

1. The pain is reduced to a minimum because of the smoothness of the new head and the covering with a double layer of fascia.
2. The use of the fascia assures a fairly extensive range of motion in the hip joint and the stability of the hip postoperatively is satisfactory.

Seven case reports with x-rays are included. These consist of three cases of ununited fracture of the hip, two cases of hypertrophic osteo-arthritis of the hip, and two cases of ankylosis of the hip. Further cases and later end results would be valuable and interesting.—*Custis Lee Hall, M.D., Washington, D. C.*

#### END-TO-END APPROXIMATION AND ACCURATE REDUCTION AS A NECESSITY IN FRACTURE THERAPY. Walter W. Ebeling. *Am. J. Surg.*, XVIII, 272, 1932.

The author discusses several interesting points which are worth considering, including the aims in fracture therapy, method of attaining accurate reduction, and a timely discussion of the satisfaction of the patient; also the criteria for sufficient reduction and the exceptions which may be met with, especially in the younger, and the necessity for accurate reduction, especially when the fracture is near or adjacent to a joint.

The author also emphasized the fact that the operating room is the place for the care of fractures, stresses the rigid asepsis, and approves of the Lane-plate technique.

The difficulty of the standardization and treatment of fractures is also discussed and the individualization of each fracture from the standpoint of the patient and his occupation, the age of the patient, the procedure indicated in reduction, type of fixation, the importance of after-treatment, and the consideration of the surgeon as an individual.—

*Custis Lee Hall, M.D., Washington, D. C.*



OPERATIVE TREATMENT OF PARALYTIC GENU RECURVATUM. Willis C. Campbell and Joseph I. Mitchell. *Ann. Surg.*, XCVI, 1055, 1932.

The operation was first described by Campbell in 1918.

The lower third of the patella is fixed in the anterior head of the tibia, the upper two thirds being left free to articulate with the femoral condyles, forming a stop-joint and preventing hyperextension of the knee.

Through a linear incision over the patella the quadriceps tendon is divided by a Z-shaped incision, the capsule of the knee joint on either side of the patella is incised, and the patella retracted downward. A portion of the infrapatellar fat pad and the articular cartilage of the patella are excised from its lower third and the patellar tendon and periosteum are stripped from its anterior surface. A cavity is made on the upper anterior aspect of the tibia by an osteotome. The denuded patella is inserted and secured by suture.

The wound is closed and the knee fixed at 160 degrees' flexion in a cast, to be worn for eight weeks, when a stop-lock brace is substituted. This operative procedure has been modified by Mitchell so that the quadriceps tendon is not disturbed.

Complete extension or even slight hyperextension is essential in paralyzed limbs to allow the knee to "lock"; it will be unstable and will flex when weight is borne.

Seven cases are reported; the operative procedure and the cases are well illustrated.—

N. T. Kirk, M.D., Major, Army Medical Corps.

SUL TRATTAMENTO DEL PIEDE TALO PARALITICO (Treatment of Paralytic Pes Talus).

O. Pellegrini. *Arch. di Ortop.*, XLVIII, 595, 1932.

Pellegrini observed that the pes talus cannot be corrected by tendon transplants of multiple muscles or the triceps sural. This method does not assure, other than the correction of the attitude of dorsal flexion, an active plantar flexion and much less the realization of a stable attitude of equinus of the foot which is necessary to compensate for the shortening of the limb and stabilizing the leg. The association of a tibioastragaloïd arthrodesis with muscle transplants overcomes the above deficiencies without any immediate or remote inconveniences.—Peter A. Rosi, M.D., Chicago, Illinois.

CALCAREOUS DEPOSITS IN THE SUPRASPINATUS TENDON. R. C. Elmslie. *British J. Surg.*, XX, 190, Oct., 1932.

Reference is made to the previous publications of Codman, Painter, and Brickner on this subject. Eight cases are reported, in seven of which operation has been done. The x-ray appearance was very characteristic in seven of the cases. Operation seemed justifiable because of the very severe pain, particularly in the acute cases. All the patients were relieved by operation, but several of them were very slow to gain full function of the shoulder. The usual findings at operation were an area of inflammatory tissue over the greater tuberosity of the humerus. It was usually a yellowish mass containing material like that in a dermoid cyst and in several instances the yellow material continued into a cavity in the greater tuberosity. In each case the cavity was curetted. In some cases it was adherent to the supraspinatus tendon and it was necessary to excise a piece of the tendon.

Pathological examination showed non-crystalline calcareous matter mixed with giant cells and inflammatory cells surrounded by fibrous tissue in various stages of development. Chemical examination showed the deposit to be calcium stearate in one case and, in another, both calcium phosphate and calcium carbonate.

The writer believes that these deposits are laid down following a tear of the muscle insertion with the usual soft-tissue damage, that the inflammatory tissue becomes calcified, and that the calcareous matter then acts like a foreign body. No x-rays are shown following operation to show that all the calcareous tissue was removed and that it had not reappeared.

**MALIGNANT GIANT-CELL TUMOUR OF BONE.** E. S. J. King. *British J. Surg.*, XX, 269, 1932.

A man of fifty-six with a tumor of the lower end of the radius of four years' duration was thought to have a benign giant-cell tumor and was treated by deep x-ray. He did not improve and operation was done five months later. Pathological examination showed what was thought to be a benign giant-cell tumor. He later developed a recurrence and amputation was done. A diagnosis of malignancy was made and the former specimen was carefully studied. Many areas did show a benign condition, but others showed malignancy. The patient died of metastases to the lungs and spine, but there was no autopsy.

No roentgenograms taken before x-ray treatment was given are shown.

**AN AMBULATORY DISTRACTION SPLINT FOR LEG FRACTURES.** E. Robert. *British Med. J.*, II, 1051, 1932.

Robert describes an ambulatory method of treating fractures of the tibia. In principle, the apparatus consists of two transfixion pins similar to Steinmann's one. One of these is hammered through each fragment. The projecting ends of each pin are then grasped by a pair of distractors, one on each side of the leg. A bolt with right and left hand threads working in sleeves, enables the ends of each distractor to be separated and strong skeletal traction to be applied to the fragments. By this means the fragments are adjusted into perfect position. The two distractors are then clamped into a fixed relationship to one another by an adjustable bridge. The patients walk after the second day. These cases have been so treated with good results.—*R. I. Harris, M.B., Toronto, Canada.*

**THE TREATMENT OF THE PARALYSES OF POLIOMYELITIS.** Jean Macnamara. *Canadian Public Health J.*, XXIII, 517, Nov., 1932.

Part I. Under "General Principles" Dr. Macnamara discusses the importance of proper care of poliomyelitis cases from an orthopaedic standpoint. She states that the survivor of an attack of paralysis has an expectation of life as long as a person not so affected, if the respiratory and abdominal muscles escape or recover. She points out the many possibilities of starting deformities while the patient is still confined to bed, and states that such deformities are "in every instance preventable".

In ambulatory cases Dr. Macnamara speaks of the great benefit derived from keeping the affected limb warm. She has found that, when special attention is paid to this, bone atrophy is less. She is doubtful about the benefits to be derived from pool treatments, except in cases with all good to normal muscles, feeling that more damage is done to weakened muscles by going without apparatus.

Part II. "Some Details of the Management of Early Cases." This part is taken up almost entirely with a detailed description of apparatus that can be made by any one for bed patients. Saline baths and heliotherapy are described and their respective benefits noted.

Part III. "Some Organizations to Provide This Care." Dr. Macnamara lists some of the organizations in this country and abroad and describes their methods of follow-up care.

**FRACTURE OF THE ANTERIOR SUPERIOR SPINE OF THE ILLIUM.** Frederick Christopher. *J. Am. Med. Assn.*, C, 113, 1933.

The author reviews the literature of this fracture and presents a case coming under his care in which it had occurred. The treatment given this patient was of a conservative nature,—merely rest with the hip in the flexed position for a time, followed by gradual resumption of activity. Other reports on this condition as given by the author show that by conservative treatment the period of disability is only about one month, while by operative reattachment of the broken process the period of disability is longer. In either case the end result is perfect.—*H. E. Hippa, M.D., Dallas, Texas.*

REDUCTION OF DISLOCATED SHOULDER: A NEW METHOD. J. W. Shumate. *J. Am. Med. Assn.*, XCIX, 2181, 1932.

The method as presented by the author consists of traction on the abducted humerus by a bandage over the operator's shoulder and hooked over the semiflexed arm of the patient. Traction is obtained by the operator leaning backward and at the same time pushing against the patient's chest with his hands. His hands on the patient's chest are in such a position that the thumbs palpate the head of the humerus and as traction draws the head out from the subcoracoid space it is pushed into the glenoid fossa.—W. B. Correll, M.D., Dallas, Texas.

RECHERCHES HISTOLOGIQUES SUR L'INNERVATION DES ARTICULATIONS DES CORPS VERTÉBRAUX. Adolphe Jung and Alexander Brunschwig. *Presse Méd.*, XL, Pt. 1, 316, 1932.

This interesting anatomical study, which emanates from the clinic of Leriche of Strassbourg, is a valuable addition to the voluminous and important contributions which Schmorl published, but whose work is not referred to.

The authors show that sensory nerves are numerous in the anterior common spinal ligament, while of much lessened incidence in the posterior common ligament. Also that the nerve trunks are myelin-free. The intervertebral disc itself contains no nerve tissue whatever.—Emil S. Geist, M.D., Minneapolis, Minnesota.

LE TRAITEMENT DES FRACTURES DU COL DU FÉMUR. L. Tavernier. *Presse Méd.*, XL, Pt. 1, 604, 1932.

The article deals with fresh fractures of the femoral neck. After reduction (traction and lateral pull) a screw is inserted through the great trochanter into the head of the femur. Control at various stages by means of successive roentgenograms.

Since no cases are reported, there is little to interest Americans who for many years have tried this and similar methods.—Emil S. Geist, M.D., Minneapolis, Minnesota.

L'ÉTAT ACTUEL DE LA QUESTION DU BACTÉRIOPHAGE. A. Seldeslachts. *Rev. Belge des Sciences Méd.*, IV, 296, 1932.

This is an excellent exposition of the history as well as the actual status of the subject of bacteriophage. The article does not lend itself to the process of abbreviation, but it ought to be translated into English. There is a fairly large bibliography, but America is poorly represented in it.—Emil S. Geist, M.D., Minneapolis, Minnesota.

SURGERY OF THE ANKYLOSED JOINT. Willis C. Campbell. *Surg. Gynec. Obstet.*, LV, 747, 1932.

This contribution to our knowledge of the ankylosed joint is based on the records of 325 arthroplasties. It is packed full of wisdom drawn from this large experience and should be read carefully by all who contemplate the mobilization of ankylosed joints. Maximum success is predicated on the close observance of many important factors. These are listed under sixteen headings which include etiology, duration, distribution, position of ankylosis, shortening, abnormal osseous structure, eburnation, osteoporosis, age, and social status and occupation.

X-ray examination before and after arthroplasty is discussed.

The operative technique is divided into three parts: (1) the plastic adjustment of the soft parts; (2) the reconstruction of bone; and (3) the interposition of tissue. Each step is described and the after-treatment is outlined.

"Unless a joint can be restored in which there is approximately normal endurance, a stiff joint in a good position is more serviceable."

At operation a minimum impairment of surrounding soft-tissue circulation is stressed, the nutrition of the bone ends being a large factor in the later functioning of the reconstructed joint.—Richard McGowney, M.D., Los Angeles, California.

# The Journal of Bone and Joint Surgery

## PRESIDENTIAL ADDRESS\*

BY ARTHUR STEINDLER, M.D., IOWA CITY, IOWA

In response to precedent and tradition most of my predecessors have dedicated their addresses to orthopaedic progress and achievements of the immediate or remote past. Many a forceful message and wise counsel, built upon such historical background, has been delivered to this Society on these occasions.

As I address you today, I too have a cause to plead, which I fancy may be of some influence upon the future development of orthopaedic surgery.

My ambition, however, does not rise to the point of delivering a message and if, in the exposition of the case, allusions are made to historical events, they are meant only to give a basic structure to the argument. There is no intention of indulging in prophecies or exhortations.

Sufficient time has elapsed since the so called independent existence of orthopaedic surgery in this country to make us thoroughly conscious of the true sources of our proficiency. We are rejoicing that these sources of knowledge have come to us from all nooks and corners of natural sciences, until we find today that clinical medicine and basic and allied sciences alike are united to supply us with food and fuel necessary for our work. History tells us, however, that the conquest of theoretical medicine and its allied fields has not always been carried on with the undivided support of the rank and file of the profession. It seems that much arguing and pleading were necessary, judging from what is reflected in the presidential expressions of earlier years.

At first, it was pointed out to this Society that it was the prominent surgeon of the old days who really did all the orthopaedic work. It is to him that we owe the establishment of the bill of rights of orthopaedic surgery among medical sciences.

E. H. Bradford, in 1889, in his address before the Association, de-

\* Read before the American Orthopaedic Association at Washington, D. C., May 9, 1933.

scribes it as a pioneer Society which owed its inception to the genius of men like Delpech, Bouvier, Malgaigne, Macewen, Stromeyer, and Thomas. These were all general surgeons of the present and past centuries. There is frequent mention of Ambroise Paré who, three hundred and fifty years ago, made clinical use of the adaptability of tissues for gradual correction of deformities, and of John Hunter who, two hundred years later, became the great champion of the restorative powers of nature.

Next, it was reasoned that inasmuch as the great surgeons of the past were orthopaedists, so the orthopaedist of today must be a surgeon before he may aspire to proficiency in his work. The acceptance of this prerequisite has actually laid the corner-stone for a standardization of orthopaedics as a surgical science. In 1894, Phelps, in his annual address, deplors the odium of the so called "strap-and-buckle specialty" and claims as indispensable background for the orthopaedic surgeon a perfect knowledge of anatomy and pathology, a viewpoint implicitly shared by Ridlon in his address (1895), when he paid particular tribute to two general surgeons of the nineteenth century, Little of London and Detmold of New York.

It is commonly assumed that orthopaedic surgery established its independence earlier in this country than it did anywhere else, thanks to the creative influence of Sayre, Phelps, and Taylor. But this must not be understood to mean that it has ever drifted away from general medicine. On the contrary, we see it has become increasingly dependent upon and affected by general medical knowledge. Osgood in his address in 1921 issued an urgent call for an all-embracing medical background for the orthopaedist. But the idea has never been better expressed than by the lamented Allison in 1922 when he pointed to the difference between the technical perfection and a real deepening of our knowledge. "If we were bent upon technical perfection alone," he said, "it would be easy to refine our methods from within themselves and devote ourselves to the cultivation of fool-proof proceedings." Indeed, all of us have seen the time when such a narrow tendency has threatened to prevail in our profession. However, later developments have borne out that the broader path, advocated by Allison, was the one chosen; orthopaedic progress appears intimately interwoven with contemporary progress of medical sciences. For this it may not deserve special credit, since this trend became universal in medicine. At any rate, we are today less specialistic than we ever were and much more universalists in medicine than our elders a generation ago. In the stricter sense, therefore, the term of orthopaedic surgeon has become inadequate; we should be called orthopaedic physicians.

The new urge for universal medical knowledge permeates actual orthopaedic practice as much as it does orthopaedic teaching and orthopaedic research. One of our committees is at present actually engaged in investigating what is and what is not good orthopaedic teaching in the light of general medicine. In the near future I hope to see a similar

committee investigating from the same point of view what is and what is *not good orthopaedic research*.

With all due deference and gratitude to the morphological sciences, anatomy and pathology in particular, the inestimable value of which may never be belittled or disputed, it is not too much to say that at present orthopaedic progress is earmarked by its alliance with physiological sciences.

There was first the biology of regeneration, particularly of bone growth, stimulated by newer operative methods. Its clinical application reaches back to Ollier, Macewen, and Lexer.

Then came biochemistry which has always played an important rôle as an ancillary branch from the days of Trousseau and Kassowitz to the present day, and which has so generously contributed to our knowledge of metabolic orthopaedic disorders that today no orthopaedic record can be considered complete without a biochemical analysis.

Then, not many years ago, there was a revival of the physiology of the sympathetic system, instigated by men like Royle and Hunter and Leriche, and productive of a wealth of theoretical investigations in this field.

Very recently orthopaedic surgery has again become particularly interested in the physiology of the endocrines, especially of the parathyroid glands. This contribution is not new, as may be learned from a study of Erdheim's earlier publications thirty years ago which established the relationship between the parathyroid glands and bone disease. Its clinical significance for the study of certain bone and joint disorders is at the moment a matter of actual controversy and is too recent in your memory to need further mentioning.

This new physiological current underlying orthopaedic progress can be illustrated by so many instances that one may well wonder if there is any corner left that has not yet been carefully exploited for what it might yield to practical orthopaedics.

There is, I believe, one field of physiology which has not yet been so explored and which, so far as practical orthopaedic surgery is concerned, is still virgin soil. I have in mind the part of physiology covering the mechanics of locomotion,—the biophysics of the locomotor apparatus. For practical applicability this field seems to promise a rich harvest; it is full of possibilities for the clinician. If this is the case, why then has it escaped exploitation? The answer is that it is complex and difficult for investigation and that it exacts a certain amount of abstract studies to which the morphologist, always dealing with concrete conceptions, is rather unwilling to devote himself.

In the historical sense, biophysics of the locomotor system is anything but new. In fact, it was almost inevitable that the physical sciences should sooner or later enter into an alliance with medicine. Yet, compared with biochemistry, biophysics today has little to offer in the line of established facts, whether they relate to physical properties of the locomotor system or to the calculation of its mechanism.

In stating that the study of biomechanics of the human body is not new, reference is made to sporadic and disconnected efforts which can be traced through almost all the history of medicine. As early as the sixteenth and seventeenth centuries, at a time when biochemistry and electrophysics were still outside the bounds of imagination, the ground was well prepared for biomechanics by Leonardo da Vinci and Galilei. It is interesting to observe that valuable physical observations on the locomotor system were made by men who were still enmeshed in the old fluid theory of Galen. Croone (1633-1648), for instance, interpreted muscle contraction, and Glisson, three hundred years ago, recognized the constancy of muscle volume in contracted and relaxed conditions. In his work "*De Motu Animalium*", Borelli (1685) was the first to depart from the purely morphological point of view by treating the subject of human locomotion from the angle of physical analysis. But he was an elementary analyst since he applied only the most elementary mechanics to his human material, and he was still largely ignorant of the intrinsic physical properties of the tissues concerned.

The school of iatrophysicists, one of the three great schools of the seventeenth century medicine, represented the biomechanical line of thought and extended its influence into the seventeenth, eighteenth, and nineteenth centuries. It is common knowledge that the discovery of electrical reaction by Volta and the promulgation of the laws of Newton laid the foundation to the later studies of Haller (1708-1777), the great physiologist who discovered the sensibility and irritability of human tissue and created a monumental background for the future development of biomechanics.

From our present point of view, even his investigations into the physics of locomotion must be considered elementary, erroneous, and inadequate. One has to turn to Hermann v. Meyer and particularly to the Weber brothers in the first half of the nineteenth century for such distinctive clinical investigations as have retained recognition to the present day. Particularly has the treatise of the Weber brothers on the mechanics of the human gait remained a classic. Claiming a wide range of authorities, from Aristotle to Borelli, from Galen to Haller, and their contemporaries Magendie and Roulin, they were able to formulate certain laws for the walking and running gait which expressed the relationship between horizontal elevation, step length, swinging angle, velocity, and force, such as are still generally acknowledged as accurate and true.

One may well imagine with what degree of skepticism such abstract studies must have been received by the rank and file of the clinicians who certainly did not see then the significance of theoretical facts for practical application. To express in mathematical terms complicated physical processes seemed too bold an undertaking. But the Weber brothers emphatically disclaimed any such ideas. They did not intend to make their observations and measurements the basis upon which general laws of mechanics were to be formulated. They knew that this would be

preposterous in the face of the many unknown factors which enter into human locomotion. On the contrary, the law being first recognized and accepted as universal, their point was to show whether and to what extent any phase of locomotion which lends itself to analytical studies could be demonstrated to conform to existing mechanical laws or, to put it in simpler terms, could be shown to be a special case of this law. This attitude of making the interpretation of locomotor events strictly contingent upon existing general laws has, I believe, steered biophysics of locomotion safely around the most dangerous cliffs and has saved it from an abyss of useless speculation. Its effect on future progress cannot be overestimated. It was in the latter half of the last century that Marey (1872), Duchenne, and later Fick, Strasser, and still later Braune and Fischer developed their classical studies on human motion and human gait. The ceaseless labor of such men has transmitted to us a wealth of data which to the casual observer may appear dry and tedious, but from the angle of mechanical laws they are full of meaning. They are as important for the dynamics of locomotion as are Culman's, Wolff's, and Roux's much quoted contributions to the statics of the human body.

Indeed, it is due to the studies of Wolff and his successors that everybody today accepts as a fact the all-important and dominant influence of mechanical laws in determining form and function of the normal system of locomotion.

Physiology has, moreover, gone considerably beyond this point when it applies the laws of thermodynamics to the study of locomotion. By this is meant a correlation of the measurable mechanical work with the amount of energy expended.

It has, thereby, built up a fairly accurate and a very much needed scientific standard for the efficiency of many of the normal locomotor events. Men like Chauveau (1897), and Amar in France (1913), Durig, Lewy, Zuntz in Germany, Benedict and Cathcart in this country, and Hill and Fenn in England, have made most valuable contributions to this problem, and so convincing have been the results of their studies on mechanical efficiencies of all kinds of locomotor activities that both physical education and industry alike were eager to avail themselves of this stock of knowledge for their own particular ends. Physiology starting with systematic observations, measurements, and trials has finally reached the point where a mathematical expression could be given to many of the locomotor events, and where, moreover, their motor efficiency could be stated in percentage figures.

Surely, if all this could be accomplished by studies of physiological motion, it is reasonable to expect similar results for pathological motor activities. I am here reminded of a thought I heard expressed by one of our most profound orthopaedic thinkers, now dead: "The cripple," he said, "is no caricature of the normal man; he is a unit, a device of nature all his own." This seems to apply, above all things, to the mechanical make-up of the locomotor system. We may well ask ourselves whether



to date physiological research has revealed an amount of facts applicable to the pathological side of locomotion, similarly as it has served normal motor activities; or whether it should be necessary to repeat the whole process of investigation from the pathological angle. To a large extent, I fear, the latter is true. Pathomechanics of the human body is still unbroken ground. There have been, it is true, sporadic investigations on selected problems. For instance, contributions have been made on the physical properties of structures making up the locomotor system. The pressure, the torsion, the bending resistances of many of the long bones are known; so are, to a degree, the elasticity and contractility of muscle tissue, and its resistance to elongation in the relaxed and contracted state. Such facts, even though arrived at from normal tissue, go far to elucidate the mechanogenesis of many pathological conditions, for instance, of fractures and muscle contractures.

Also, the various problems of equilibrium have been analyzed nicely for the upright position in a number of weight-bearing joints.

This sort of analysis, however, has not been carried over much into pathological situations. Posture, for instance, is still defined largely in purely morphological terms and, though gravital stresses are, of course, generally recognized as being the basic factor, there are few, if any, investigations which treat the situation from the viewpoint of mechanical analysis of the external gravital forces as they act upon the human body.

Sequence and coordination of muscles in any kind of concerted motion is another field of analysis. Here, we are particularly indebted to Scherb of Zurich for his studies of so called myokinetics of certain types of motion. These investigations of the plan and arrangement of muscle action—the muscle score as it might be called—are very valuable, because they can be used for pathological situations and very useful information can be obtained in regard to the substitutionary properties of muscle action or in regard to functional adaptability of transplanted tendons.

There are many other lines of biophysical research which may be carried over to pathological territory. For instance, action-current readings have been made in all kinds of paralytic and spastic conditions. As an index of pathological muscle activity, such readings throw light on more than one perplexing situation in locomotor disturbances.

Another very promising field is the study of energy consumption in pathological motion. Just as it enables us to arrive at an index of proficiency for normal motion, so it may do for the abnormal, and one may well imagine what convincing record it would make before and after treatment, if endurance as well as proficiency could be calculated and compared with standard values.

I do not need to go any further to prove that the field is vast and largely unexplored. It is safe to say that a considerable time will elapse before sufficient theoretical facts are available for practical clinical use. However, there is comfort in the thought that other basic sciences have met with similar fate; they, too, had to develop quietly in the background

of clinical medicine before the sheer weight of their vast and useful practical information forced their recognition.

I trust that I have not allowed my zeal to overstep the bounds of impartial reasoning. But I visualize biomechanics as a powerful and indispensable ally of the orthopaedic clinician. Many of my colleagues, I trust, will be attracted by the intriguing problems in this field and I hope to see the day when systematic and coherent research in the domain of biophysics of locomotion will open the way for greater proficiency and will mark a definite advance in orthopaedic surgery.

Two years ago, Gentlemen, you honored me above all merits by the election to this office. I am grateful to you beyond words, my gratitude being only intermingled with misgiving lest I have not been able to conduct this office on the high standard to which it has been elevated by my more illustrious predecessors. You may recall that on that occasion I indicated my faith in the future importance of biophysics for orthopaedic surgery, an opinion which, if my memory serves me right, you graciously accepted.

Today, in my presentation, I again have set before you this line of thought, to which I have devoted much time and study, as an article of my orthopaedic faith. Allow me to place it in your hands with the assurance of my undying loyalty to you and to American Orthopaedic Surgery.

# INFANTILE DEFORMITIES OF THE KNEE AND HIP\*

BY OBERREGIERUNGS-MEDIZINALRAT DR. MAX BÖHM, BERLIN, GERMANY

I feel very much indebted for the opportunity you have given me to demonstrate here my research work of recent years.

What do we know about the cause of infantile deformities of the leg,—for instance, of knock-knee, of bow-leg, or even of flat foot? We know that all these deformities may be produced by many different causes, such as rickets, poliomyelitis, osteomyelitis, or old fractures.

But, aside from these recognized causes, there still remains a rather large number of cases, in which the etiology is unknown. Among these are cases of a certain type of deformity of the leg,—such as a bow-leg or a knock-knee, or a hyperextended knee, a weak ankle, or a flat foot—rarely a deformity of an extreme type, but mostly of a moderate or of a mild degree, so that sometimes there is very little difference from the normal.

These deformities which we meet daily show no history of rickets, osteomyelitis, or old fractures. They cannot be attributed to any of the known causes and, therefore, they have been explained by all possible theories and hypotheses.



FIG. 1

Upper epiphysis of the tibia in foetus of seven months. (By courtesy of *Zeitschrift für Orthopädische Chirurgie*.)

In accordance with the mechanical conception of natural science in general, in the past century, these “*infantile*” deformities—as I like to call them now—were explained by mechanical causes. We believed in a wrong function, in a faulty attitude, in the effect of overweight,—in brief, in abnormal static conditions—all this without any real basis, without any proof; we believed simply because we did not know better.

I do not wish to add a new theory to the dozen of old theories, but to try to put the etiology of infantile deforma-

tions, as we now understand them, on an anatomical basis.

In this paper we are to consider especially the deformities of the knee and hip.

## DEFORMITIES OF THE KNEE

### *Genu Varum.*

A brief, anatomical, comparative study shows that in the anthropoid the condyles of the tibia differ widely from each other; the lateral one is

\* From a paper presented at the Meeting of the British Orthopaedic Association, London, July 27, 1932.

always much broader and higher than the medial one, whereas in an adult man both tibial condyles are equally high and both show a concave joint surface.

An x-ray of the tibial epiphysis of a nearly adult gorilla shows a marked asymmetry that means the overdevelopment of the lateral and the underdevelopment of the medial condyle. In a young human foetus (Fig. 1) it is evident that the tibial epiphysis still has anthropoid characteristics,—the lateral condyle is high and convex; the medial condyle is low and concave. If the two joint surfaces are placed horizontally, the shaft of the tibia is deviated inward and a genu varum results.

In young children the tibia is similar to the foetal tibia; a cross section shows that the lateral condyle is high, the medial low; that the lateral is convex, the medial concave; and finally that the shaft is deviated inward.

In a child of about twelve years of age the conditions are entirely different (Fig. 2). The epiphysis is now symmetrical; both tibial condyles are of the same height; both are concave; and the shaft is now straight.

If the child grows and the tibia keeps its foetal type, a genu varum results.

#### *Genu Recurvatum.*

Quite often young children show a *hyperextended* knee, particularly in connection with a genu varum or genu valgum. What is the cause?

The knee of the anthropoid shows an interesting feature,—the head of the tibia is curved backward. The same recurvation is to be seen in the human foetus. In a mild degree it is present in the young child and not until the tenth year do the recurvation and the subsequent inclination of the joint disappear.



FIG. 2

Upper epiphysis of the tibia in child seven years old. (By courtesy of *Zeitschrift für Orthopädische Chirurgie.*)



FIG. 3

Model of lower epiphysis of the femur in embryo of two months. (By courtesy of *Zeitschrift für Orthopädische Chirurgie.*)



FIG. 4

Lateral view of acetabulum in foetus of five months. (By courtesy of *Zeitschrift für Orthopädische Chirurgie*.)

must result. The roentgenograms of clinical cases of infantile hyperextended knees show clearly the recurvation of the tibial head.

#### *Genu Valgum.*

Study of the knee of an anthropoid shows that there is a marked difference in the volume and height of both femoral condyles. The medial is much larger and higher than the lateral condyle. In a roentgenogram of the knee of an anthropoid almost an adult, the underdevelopment of the lateral femoral condyle may be seen very clearly. It is only in the human *adult* that both condyles are of equal size and that the lateral one shows the same height and shape as the medial. I have studied very many human knees of different ages before and after birth and have found in all knees of embryos an underdevelopment of the lateral femoral condyle (Fig. 3). The same is true of the knees of all foetuses examined, as is shown in cross sections. Finally, even the femora of children show the difference in the height of the condyles, in a measure comparable to the age of the child.

If the foetal underdevelopment of the lateral condyle persists, it is clear that a genu valgum must result.

What do the roentgenograms of clinical cases of knock-knee show? The typical appearance in the cases which are undoubtedly due to rickets is the deviation of the shaft and of the diaphysis or the metaphysis, whereas the epiphysis and particularly the condyles show no abnormality in shape or height. On the other hand, the x-ray of an infantile—as I call it now—genu valgum, a so called static genu valgum, shows no

Furthermore, the condyles of the femur in the anthropoid differ in an interesting way from those in the human being. In man the femoral condyles show the well known curve, which may be best compared with the curve of a sledge; in the adult anthropoid the curve forms a part of a circle.

The development of the femoral condyles during childhood may be mentioned. These are round in the embryo, in the foetus, and in the new-born, gradually changing to the final flat shape evident in the adult.

If the recurvation of the tibia and the round shape of the femoral condyles persist in childhood, a hyperextended knee



FIG. 5

Posterior view of the acetabulum in foetus of five months. (By courtesy of *Zeitschrift für Orthopädische Chirurgie*.)

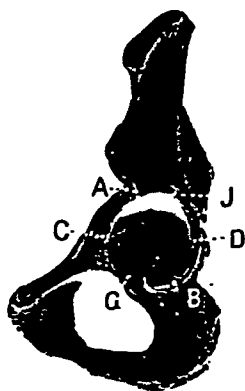


FIG. 6

Lateral view of the acetabulum in an adult. (By courtesy of *Zeitschrift für Orthopädische Chirurgie*.)

entirely lacking, for instance, in the gorilla. The gorilla does not need this posterior roof on account of the peculiar inclination of the pelvis.

The acetabulum of the human foetus shows the same characteristics as that of the gorilla,—that is, a roof is found only above; the posterior roof is entirely lacking. Besides this, there are differences in the shape of the acetabulum; the acetabulum of a human adult is round like a circle; whereas that of a gorilla is oval in shape like a lemon. The human foetus has likewise an acetabulum of oval shape. If a human foetus suddenly started to walk with a straight leg and with an inclined pelvis just like a human adult, the head of the femur doubtless would slip out!

If we study cases of dislocation of the hip in very young children who have not walked and where no therapeutic manipulation has been done, we find exactly the anatomical conditions of the acetabulum of a foetus,—that is, lemon-shaped and lacking the posterior roof.

#### SUMMARY

If I were asked to give a summary of my research work of the past ten years, I would say:

Just as in modern medicine we know that there is a predisposition to certain diseases, such as tuberculosis, so there is likewise in certain human beings an inherited disposition to certain infantile deformities, based upon an arrest of development in certain parts of the skeleton,—particularly of the ankle, knee, and hip joints and their epiphyses. If this arrest of de-

viation of the diaphysis, and the shafts of the tibia and femur are straight; but the epiphysis is asymmetrical; the lateral condyle is developed less than the medial, is decidedly small, short, low, and very little curved,—exactly as we find it in the knee of the embryo or foetus.

#### CONGENITAL DISLOCATION OF THE HIP

The chief difference in the construction of the acetabulum between man and the anthropoid is the following: The human acetabulum has a roof above and behind. This roof, which prevents the sliding of the femoral head, is



FIG. 7

Posterior view of the acetabulum in an adult. (By courtesy of *Zeitschrift für Orthopädische Chirurgie*.)

velopment continues during childhood, the erect position and the gait produce, increase, and stabilize deformities.

As to the cause of this arrest of development, two points are of significance: We know clinically that the infantile deformities have a tendency to familial and hereditary appearance and that anatomically their morphological substratum is identical with the normal conditions of certain animals, such as the anthropoid. Thus I consider the infantile deformities as congenital in a wider sense.

## LUMBOSACRAL FACETECTOMY FOR POST-FUSION PERSISTENT SCIATICA

BY PAUL C. WILLIAMS, M.D., AND LUIS YGLESIAS, M.D..  
ANN ARBOR, MICHIGAN

*From the Department of Surgery, University of Michigan*

It is a well recognized fact that there are occasionally cases of sciatica which do not get relief from either a trisacral or a lumbosacral fusion.

Recently there was published in the *Journal of the American Medical Association*<sup>1</sup> an article in which was described a lesion of the lumbosacral joint which in this clinic had been found in seventy-four per cent. of the cases suffering with sciatica due to pathological bone or joint changes. The lesion consisted of a narrowing or a complete loss of the lumbosacral intervertebral disc, which in turn had caused a subluxation of the joints formed by the articular facets of the fifth lumbar and first sacral vertebral bodies, a constriction of the foramina formed by these segments, and an arthritic lipping of the adjacent surfaces of these two bodies, which had resulted from the abnormal contact and stress following the loss of the disc.

From a roentgenographic standpoint, it is well to divide these patients into two groups: first, those whose roentgenograms show a complete loss of the disc; and second, those whose x-rays show a narrowing of the lumbosacral disc only posteriorly. An example of the first type is shown in Figure 1; Figure 2 is an example of the second type. The latter usually causes more confusion as to its interpretation than does the former, being read frequently as a normal lumbosacral spine. This error is demonstrated in the anatomical specimen and its roentgenograms, shown in Figures 5, 6, 7, and 8. The mechanical alteration in the region of the articular facets and foramina and, therefore, the irritation of the fifth lumbar nerve roots is as great, if not greater, in the second group, than in the first.

The roentgenographic finding shown in Figure 2 is a very common lesion, which probably is the reason that no significance has been attached to it. However, in our experience every patient, whose x-rays show this finding, gives a history of pain in the lower part of the back and down one or both extremities, which usually occurs in attacks. One should bear in mind that this is a condition which in most cases does not produce continuous symptoms. It is, therefore, possible to find the lesion in patients who are not complaining of the characteristic symptoms and who do not present the usual clinical findings. However, a history will reveal that they are subject to attacks of what they usually term "lumbago" and "sciatic rheumatism".

We do not wish to imply that all cases of sciatica are due to pathological bone or joint changes, nor that those which are, are all due to a





FIG. 1

Lumbosacral spine of patient suffering with sciatica. Note complete loss of the lumbar sacral intervertebral disc and the arthritic lipping.

loss of the lumbosacral disc. Every case should have a thorough neurological examination and the usual search for any toxic chemical or mechanical irritation. However, as we continue our study of this disease, we find that the number of cases showing a reduced lumbosacral joint space fully sustains the percentage indicated in the original article, while cases due to lumbosacral anomalies undoubtedly constitute a larger percentage than originally indicated. This is especially true in those cases showing a unilateral sacralization of the fifth lumbar vertebra and in those showing a lumbarization of the first sacral vertebra. We believe that irritation of the nerve root in

this group is due to practically the same mechanical alteration as in those cases showing a loss of the lumbar sacral disc.

There is considerable confusion as to the application of the terms sciatic neuralgia and sciatic neuritis. The neurologist makes the diagnosis of sciatic neuritis when there are definite motor or sensory changes, while the term neuralgia is applied to those cases which have pain without neurological changes along the course and distribution of the sciatic nerve. It is our opinion that most cases start with a neuralgia and, as the irritation increases in severity and the clinical course becomes prolonged, there may be both motor and sensory changes, so that the end stage of a severe case presents a sciatic neuritis. This clinical picture is uncommon as compared to the number of neuralgias one sees. In many respects a sciatic neuritis compares favorably with the clinical course of a neuritis of the upper

extremity resulting from pressure produced by a cervical rib, except that the latter usually runs a longer clinical course.

The pain in a sciatic neuralgia and the nerve changes in a neuritis are usually confined to the distribution of the fifth lumbar nerve segment. This is verified in a case of neuralgia by the fact that one of the most common sites of complaint is the sacroiliac and superior gluteal region, or the region supplied by the superior gluteal nerve which is principally a branch of the fifth lumbar nerve segment. The other common site of pain is the posterior lateral aspect of the calf and ankle, which area corresponds to the sensory distribution of the fifth lumbar segment. In two cases



FIG. 2

Lumbosacral spine of patient suffering with sciatica. Note that anterior width of lumbosacral disc is retained, but posteriorly the width is entirely lost. The slight posterior displacement of the fifth lumbar vertebra on the first sacral, as shown in this case, is not an uncommon occurrence in this lesion.

of neuritis which we have seen during the past year, both of which had

TABLE I  
INNERVATION OF THE LEG MUSCLES

<i>Muscle</i>	<i>Nerve Supply</i>			
Flexor digitorum longus.....	5L	1S		
Tibialis posticus.....	5L	1S		
Flexor hallucis longus.....	5L	1S	2S	
Peroneus longus and peroneus brevis.....	4L	5L	1S	
Gastrocnemius.....			1S	2S
Soleus.....			1S	2S
Tibialis anticus...	4L	5L	1S	
Extensor hallucis longus.....	4L	5L	1S	
Extensor digitorum longus...	4L	5L	1S	

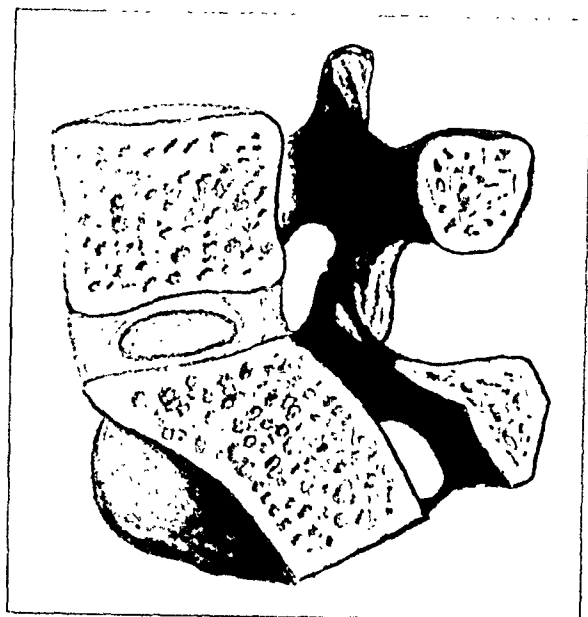


FIG. 3

Schematic drawing, showing median sagittal section of a normal lumbosacral articulation.

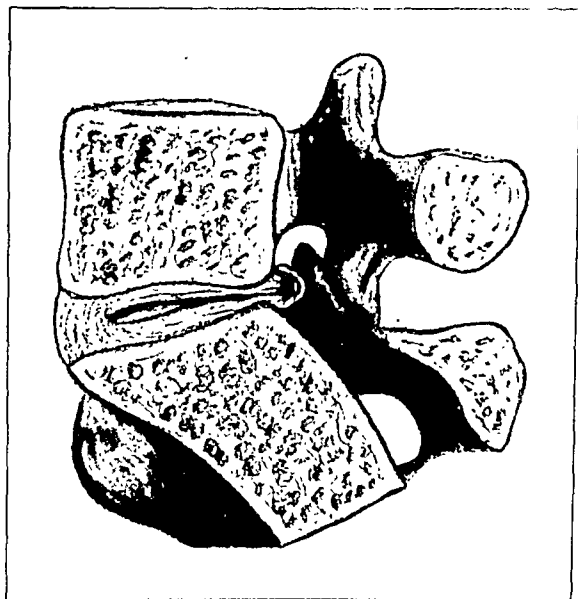


FIG. 4

Schematic drawing, showing the changes which take place following a posterior rupture of the nucleus pulposus of the lumbar disc. Note subluxation of facets, closure of foramen by the altered position of the first sacral facet, and the prolapse of the annulus fibrosis into the neural canal.

which the articular surfaces of the facets are in a transverse or an oblique plane. When the articular surfaces are in the anteroposterior plane the downward excursion of the inferior facets of the fifth lumbar vertebra is stopped by the superior margins of the laminae of the first sacral vertebra (Figs. 3, 4, 5, 6, 7, 8, 9, 10, and 11).

Motion at the lumbosacral joint undoubtedly greatly increases the irritation, in that flexion tends to open the foramina and thereby partially

motor changes, there was, on the side affected, a marked paresis of all muscles of the leg except the gastrocnemius and soleus, which presented normal function.

The innervation of the leg muscles according to most of the standard textbooks are given in Table I.

It is evident from this chart that the fifth lumbar nerve is the only segment which innervates all of the muscles which were affected and not those unaffected. Since signs and symptoms are confined to this segment alone, it is logical to conclude that the irritation is proximal to the point at which the fifth lumbar nerve root joins the sciatic trunk. This corresponds closely to the conclusions of Danforth and Wilson.<sup>2</sup>

The fifth lumbar nerves as they emerge from the neural canal occupy approximately the upper half of the foramina and lie in contact with the anterior superior surfaces of the articular facets of the first sacral vertebra. With the subluxation which must follow a loss of the intervertebral disc, the inferior facets of the fifth lumbar vertebra move down and backward, thereby closing off the foramina and causing pressure on the nerves as they emerge. The subluxation is most severe in those cases in



FIG. 5

Median sagittal section of lumbosacral articulation in an anatomical specimen. Note posterior rupture of nucleus pulposus, prolapse of annulus fibrosus into neural canal, subluxation of facets, and closure of foramen. The articular surfaces of the facets in this specimen are in an anteroposterior plane.



FIG. 6

Same specimen as shown in Fig. 5, with lumbar and first sacral vertebrectomy. Note increased circumference of foramen formed by the lumbar and first sacral vertebrae.



FIG. 7

Roentgenogram showing lateral view of specimen shown in Fig. 5. Note that lumbosacral disc is narrowed posteriorly only.

frees the nerves, while extension causes a greater constriction of the foramina and an increased pressure on the nerves. Complete fixation of the lumbosacral joint by means of a plaster spica for a period of twelve to fifteen days will give at least temporary relief of sciatic pain in the greater percentage of cases. In a similar manner a lumbosacral fusion, by remov-

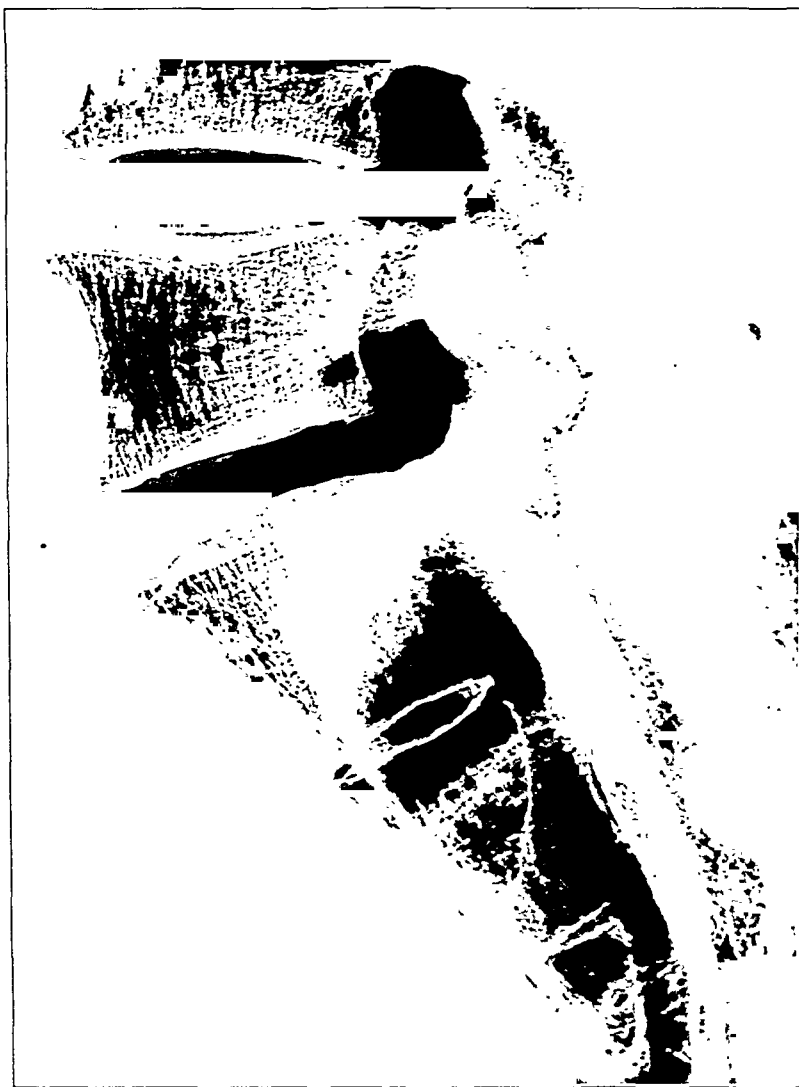


FIG. 8

Roentgenogram showing lateral view of specimen shown in Fig. 6. Note restoration of joint space.

ing the factor of motion, will give permanent relief in the majority of cases suffering with pain in the lower back and sciatic irritation. However, it is reasonable to believe that in those cases where there is a marked subluxation of the joints formed by the articular facets of the fifth lumbar and first sacral vertebral bodies, and therefore the constriction of the foramina is severe, the removal of motion alone will not relieve the irritation of the fifth lumbar nerve segments. It is our opinion that this accounts for many cases which have failed to get relief from trisacral and lumbosacral fusions.

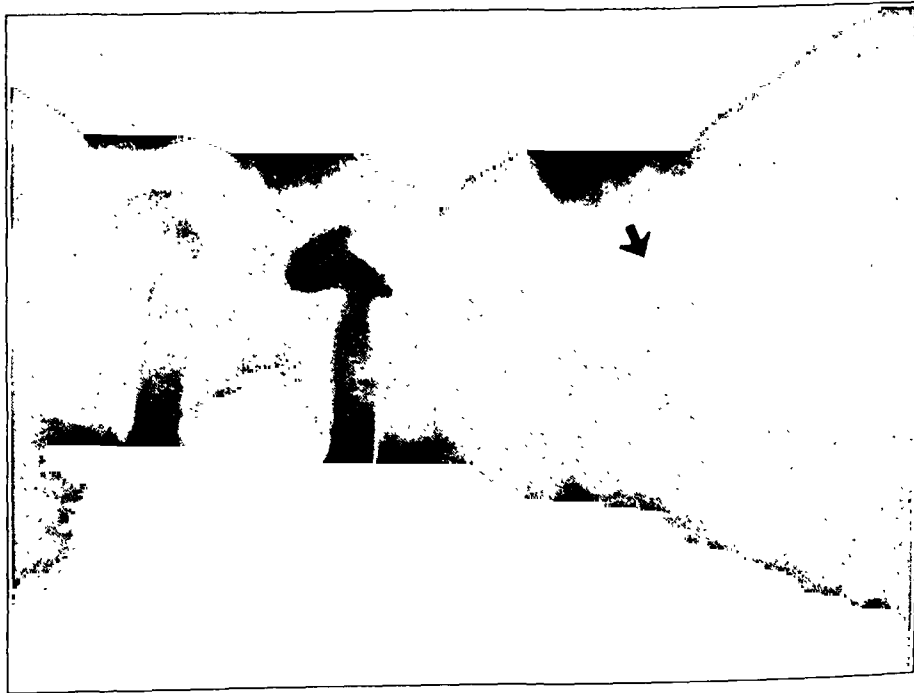


Fig. 9

Lateral views of lumbosacral spines of patients suffering with sciatica. Note loss of joint space, subluxation of facets, and closure of foramina by altered position of first sacral facets.



Fig. 10

Note loss of joint space, subluxation of facets, and closure of foramina by altered position of first sacral facets.



Fig. 11

Lateral view of a normal lumbosacral spine. Note normal appearance of the lumbosacral facets.

We advise a fusion only in persistent cases without primary neural pathological changes in which all forms of conservative treatment have failed to give relief and in which the roentgenograms show definite pathological bone changes. Thirteen such cases have been operated on during the past eighteen months. All but one have been completely relieved of symptoms. This one was a case of unusual interest.

A man, aged forty-eight, gave a history of intermittent attacks of pain in the lower part of the back, and sciatica occurring since the age of nineteen, at which time he sustained an injury to his back. Numerous attacks of such a nature had occurred as the result of lifting. For the past three years the pain had been constant and he had gradually developed a weakness of the muscles of the leg together with a numbness over the posterior lateral aspect of the calf and ankle. Symptoms were so severe that he had remained in a sitting or reclining position for the greater part of the past two years. When attempting to walk, he occasionally experienced a sudden severe lancinating pain in the extremity which would cause him to fall to his knees.

Examination revealed the findings characteristic of a severe left sciatic neuritis. There was a marked weakness of all muscles which received part of their nerve supply from the fifth lumbar segment and a hypalgesia over the area which corresponded to the sensory distribution of the fifth lumbar nerve. There was atrophy of both the thigh and calf.

Spinal roentgenograms revealed a marked narrowing of the lumbosacral intervertebral disc and a localized arthritic reaction at this site (Fig. 12).

He was treated by conservative methods without appreciable relief. A lumbosacral fusion was advised and accomplished by means of a bone graft taken from the right tibia. He remained on a Bradford frame for two and a half months following operation. During his convalescence he was free from pain in the lower part of the back, but was able to elicit pain along the course of the sciatic nerve by twisting his leg into certain positions. Straight leg raising caused pain during his entire stay on the frame. After getting up he was entirely free from pain in the lower part of the back. However, the pain along the course of the left sciatic nerve persisted and was soon as severe as before the operation. Sensory and motor changes persisted. He was unable to walk more than ten to fifteen steps without sitting down, which he did by taking his weight on the right buttock.



FIG. 12

Lateral view of lumbosacral spine of the case herein presented. Note arthritic reaction and narrowing of the lumbosacral intervertebral disc.



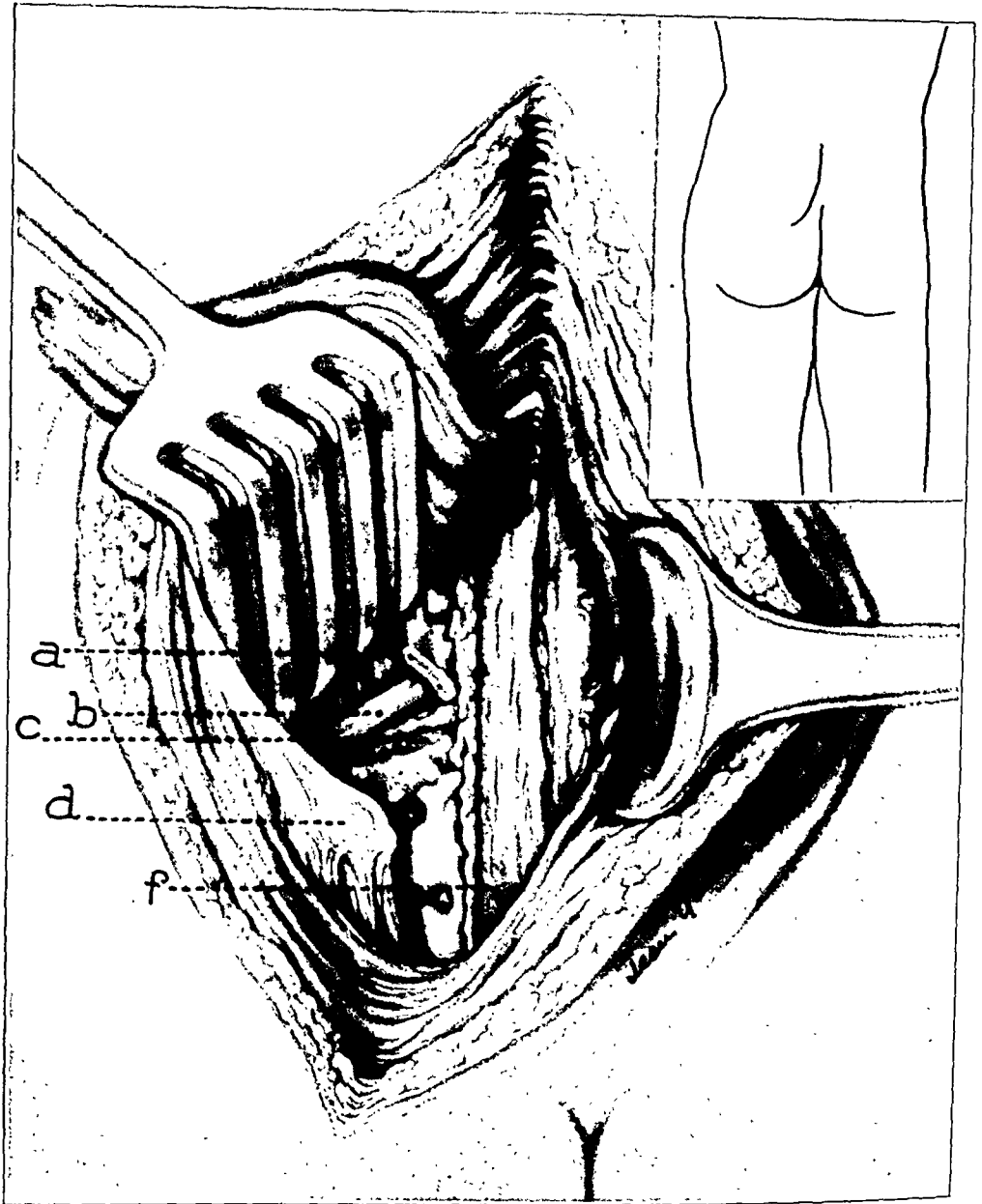


FIG. 13

Exposure of the left fifth lumbar nerve root.

- a. Pedicle of left inferior facet of fifth lumbar vertebra.
- b. Fifth lumbar nerve root.
- c. Pedicle of left facet of first sacral vertebra.
- d. Posterior-superior iliac spine.
- f. Bone graft.

allowing the left hip to remain extended and the knee flexed. Conservative methods were again employed in the form of traction, epidural injections of novocain, and injection of the left fifth nerve at the point at which it emerged from the foramen, none of which gave more than temporary relief.

On the strength of our conviction that the sciatic pain was due to constriction of the foramina between the fifth lumbar and first sacral vertebrae and therefore irritation of the fifth nerve segment, an operation was planned and performed. A curved incision about six inches long and just to the left of the mid-line was made from the level of the third lumbar vertebra downward and laterally to a point about half-way between the sacro-iliac joint and the third sacral vertebral segment (Fig. 13). This permitted an exposure of the lumbodorsal fascia. The incision was continued in the mid-line until

the graft was encountered and carried down to the third sacral vertebral segment. The erector spinae muscle was dissected subperiosteally from the graft, sacrum, and posterior superior spine of the ilium and reflected upward. This gave an exposure of the joint formed by the left lumbosacral articular facets. It was found that an excellent lumbosacral fusion had resulted from the previously placed bone graft. The joint formed by the left articular facets of the fifth lumbar and first sacral vertebrae presented a subluxation. The left inferior articular facet of the fifth lumbar vertebra was removed, affording an exposure of the articular surface of the sacral facet. This was found to be irregular and sharpened, suggestive of an arthritic reaction. The sacral facet was then removed and the fifth lumbar nerve was found to lie immediately in contact with its anterior surface. The nerve was freed from the surrounding tissues from the point at which it emerged from the neural canal to that at which it went anteriorly over the sacrum. The wound was closed in layers (Fig. 13).

Convalescence was uneventful and after two weeks the patient was allowed up. Due to his enthusiasm over the result he became rapidly ambulatory. From the time he reacted from the anaesthetic he experienced no further pain in the extremity. He was discharged four weeks after the operation with a marked return of both motor and sensory function. There was no pain to pressure at any point along the course of the nerve and the patient could walk indefinitely without discomfort.

A reexamination two months following the operation revealed a normal extremity. There was a full return of both motor and sensory function. The patient was walking from five to ten miles a day over rough ground, training his dogs for the fall hunting season. It is now eleven months since the operation and the patient is entirely free from symptoms.

From a study of approximately 500 cases of reduced lumbosacral joint space with sciatic irritation, we are convinced that the lesion in most cases is due to trauma, and the pathology is probably a rupture of the nucleus pulposus of the lumbosacral intervertebral disc. The trauma usually consists of a compression injury and for this reason the lesion is occasionally seen associated with compression fractures. The patient is usually aware of a "snapping sensation" in the lower part of the back. The pain, which as a rule follows immediately, is described by the patient as a "catch" in the back or "lumbago". Gradual relief is obtained by rest, but recurrent attacks are apt to be initiated by lifting or hyperextension injuries. The earliest symptoms of nerve-root irritation are likely to be gluteal pain and tenderness usually interpreted as sacro-iliac pathology, but which we believe to be due to irritation of the superior gluteal nerve through the fifth lumbar segment. The fibers of the superior gluteal nerve are peripherally placed within the fifth lumbar nerve root and are, therefore, the first to register irritation.

All cases should be treated conservatively. However, it is our experience that those cases showing a severe narrowing of the lumbosacral joint space with a resultant closure of the foramen and localized arthritis will eventually require surgical treatment for relief of symptoms. The tendency in this Clinic is to advise fusion earlier than has been our custom in the past. This is due principally to the fact that these patients are very apt to develop a severe psychoneurosis and not uncommonly become addicted to drugs if pain is allowed to continue without relief. It is an injustice to treat these patients by modern forms of suggestive therapy, when there is definite evidence of a lumbosacral lesion, unless methods are then instituted for treatment of their actual and primary pathological

changes. Thirty is the average age at which symptoms appear in this group of patients. If we wait for a spontaneous cure, aided by conservative methods of treatment, it means that many of these patients are doomed to semi-invalidism during the most productive period of their lives, as symptoms are likely to persist intermittently for many years under such treatment. We therefore believe that from a standpoint of economy early fusion is indicated in many cases.

If conservative treatment fails we advise a lumbosacral fusion. We are no longer doing trisacral fusions for sciatica. In those cases which show definite roentgenographic evidence of sacro-iliac pathological changes, which in this Clinic constitute less than five per cent., we advise a sacro-iliac fusion, unless there is roentgenographic evidence of associated lumbosacral pathological changes. An exposure of the fifth lumbar nerve root by removal of the lumbosacral articular facets on the side affected is advised in those cases in which there is x-ray evidence of a narrowed lumbosacral joint space and in which a lumbosacral fusion has failed to give relief. This procedure could well be carried out at the original operation; however, in so doing, one might jeopardize the health of the patient since a lumbosacral subluxation might occur if for some reason the desired lumbosacral fusion did not take place. The second operation, providing a satisfactory fusion has resulted from the first, requires but from ten to twelve days' convalescence.

Recently it has been called to our attention that Ghormley in 1931 reported a case of sciatica of two and one half years' duration, in which he enlarged the foramen of the fifth lumbar nerve by removal of a portion of the facets. Immediate and complete relief of symptoms followed.<sup>3</sup>

#### SUMMARY

1. A sciatic neuritis is usually the late stage of a sciatic neuralgia.
2. The pain in a neuralgia and the nerve changes in a neuritis are usually confined to the distribution of the fifth lumbar nerve segment.
3. The pain and nerve changes are most commonly the result of irritation of the fifth lumbar nerve root, caused by a subluxation of the articular facets of the fifth lumbar and first sacral vertebrae and, therefore, a constriction of the neural foramina formed by these bodies.
4. Fixation of the lumbosacral joint by fusion will give relief of symptoms in the vast majority of cases.
5. A lumbosacral facetectomy, after fusion had been accomplished, gave complete relief of symptoms in the one case in this series which failed to get relief from a lumbosacral fusion.

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# UNUNITED ANOMALOUS EPIPHYSES OF THE INFERIOR ARTICULAR PROCESSES OF THE LUMBAR VERTEBRAE\*

BY B. H. NICHOLS, M.D., AND E. L. SHIFLETT, M.D., CLEVELAND, OHIO

*From The Cleveland Clinic Foundation*

An ununited epiphysis of the inferior articular processes of the lumbar vertebrae, so far as we know, has not been described previously. Attention has been directed to its importance on account of the similarity to cases of fracture as described by Koch.<sup>1</sup>

A review of the embryological and anatomical development of the typical vertebrae does not disclose a description of a separate epiphysis for the inferior articular processes.

A detailed anatomical description of the adult vertebrae is not necessary in this paper. The anatomy of the articular processes of the lumbar vertebrae, however, should be kept in mind in order that the illustrations may be better understood. Anatomically the articular processes are well defined. The facets on the superior processes look backward and medialward and are concave; those on the inferior are directed forward and to the side and are convex. This causes the articular surface of the facets to occupy an anterior posterior plane in the lumbar vertebrae. The superior processes are farther apart than the inferior. The laminae are broad and are nearly vertical and support the inferior articular processes on their lower margins. These various characteristics are fairly well detailed on the anteroposterior roentgenogram of the lumbar vertebrae.

The reports of seven cases of anomalous formation of the inferior articular processes of the lumbar vertebrae are presented. These were discovered during routine examinations of the lumbosacral region and of the genito-urinary tract. Most of these examinations were made because of non-radiating pain in the lower back which increased with exertion. Two patients gave a definite history of trauma, but in most of the patients the back pain was not associated with injury. Two men in the group had chronic prostatitis; three were laborers doing heavy work requiring some lifting; one was a physician whose chief disability was hypertensive heart disease; and there was one woman whose chief complaint was chronic constipation and lumbago. The ages of the six men varied from twenty-five to fifty-seven years; the woman was forty years of age.

The two patients (Cases 2 and 3) who presented a definite history of trauma had other developmental abnormalities in addition to the anomaly of the inferior articular processes. One had bilateral lumbar ribs; the other, a non-fusion of the laminae of the first sacral segment, and an anomalous articulation between the fifth lumbar vertebra and the sacrum on the right side. It is significant that in the first case a diagnosis of fracture of the lumbar vertebra had been made elsewhere. When he was

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examined at the Clinic there was no evidence of any old or recent injury. This patient, therefore, was attempting to obtain compensation because of an erroneous diagnosis. The condition described was unilateral in four patients and bilateral in three. The second lumbar vertebra was involved in every case in this series.

CASE 1. A woman, aged forty years, complained of chronic constipation, recurring attacks of "lumbago" following head colds, and stiffness in the back and shoulders. The physical and laboratory examinations revealed nothing of significance except a slightly enlarged thyroid gland, and a stiff spine with moderate lower dorsal scoliosis. The lumbar spine deviated definitely to the left, and there was marked restriction of movement forward and to the left and right. The movement backward was not so

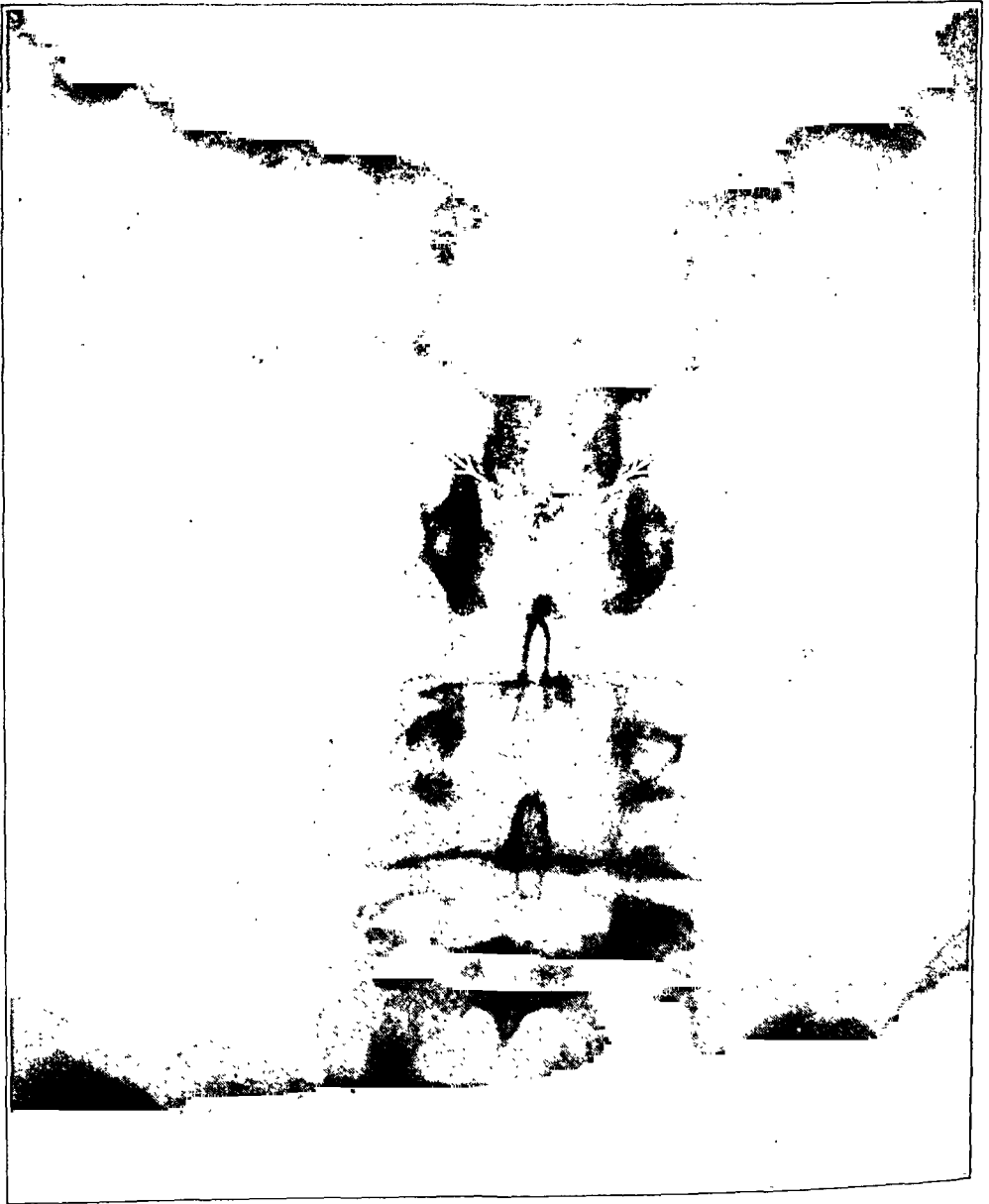


FIG. 1

Case 1. Anomaly of inferior articular process of second lumbar vertebra, bilateral.

difficult. There was considerable spasm of the muscles in the lumbar area, and marked tenderness over the third and fourth lumbar spinous processes, over each lumbosacral joint and over the right sacro-iliac joint. The patient experienced moderate discomfort on straight leg raising. Except for slight crepitation in the elbows and knees, all other joints apparently were normal.

The roentgenogram of the spine showed an anomalous, incomplete fusion of both inferior articular processes of the second lumbar vertebra (Fig. 1).

CASE 2. A man, aged twenty-five, presented himself in 1925, complaining of pain

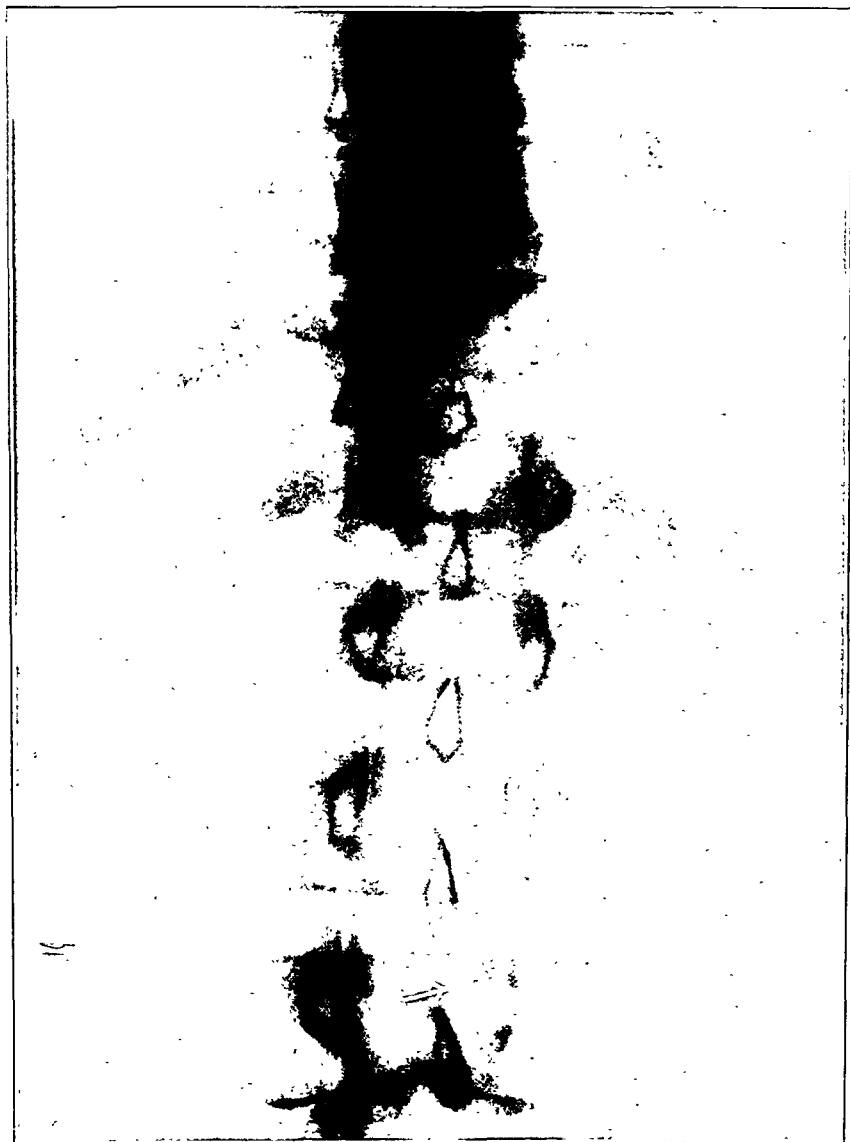


FIG. 2

Case 2. Anomaly of inferior articular process of second lumbar vertebra, left side.

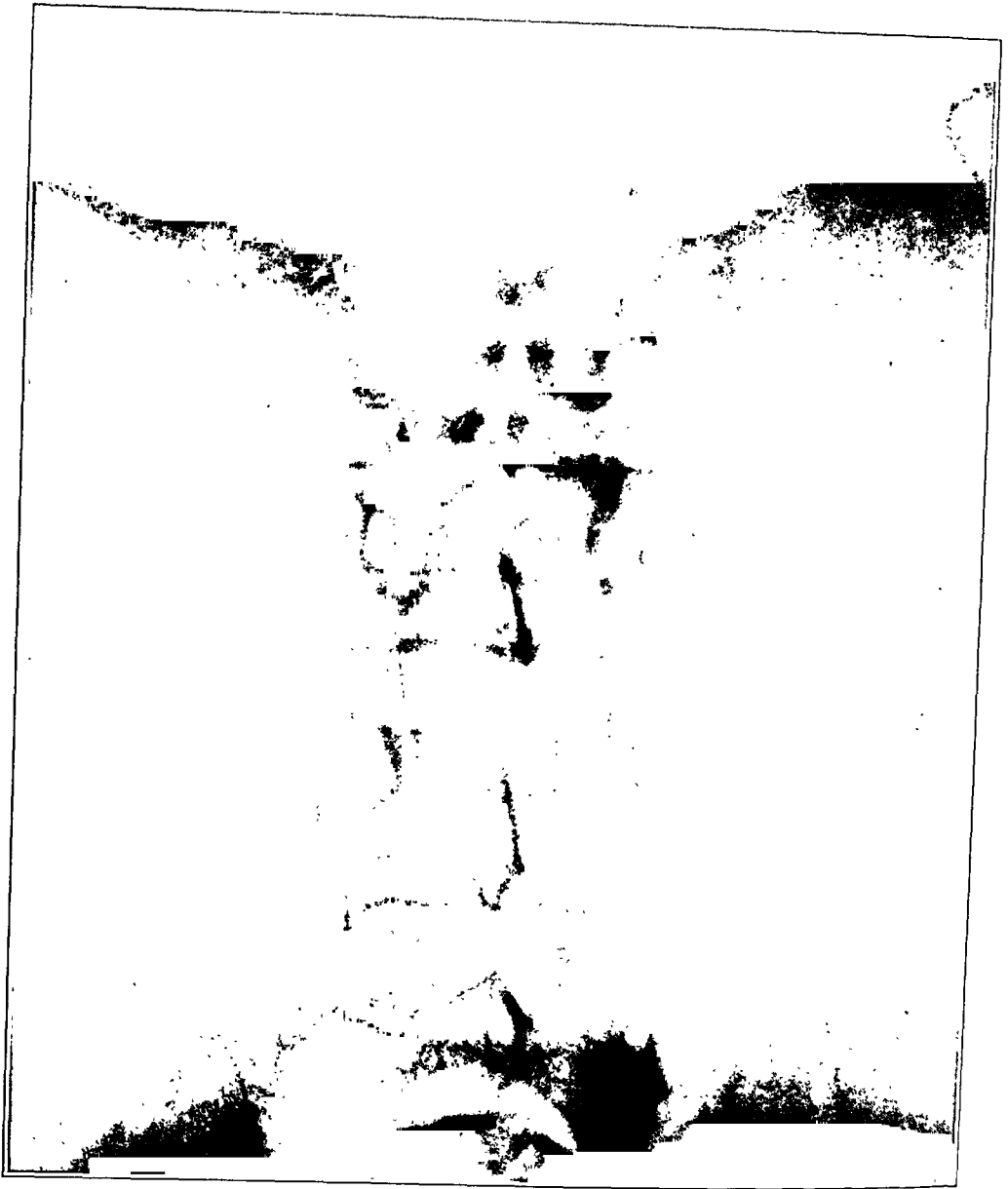


FIG. 3

Case 3. Anomaly of inferior articular process of second lumbar vertebra, left side.

in the lower back. In February 1925, while lifting one end of a bar weighing 100 pounds, he had been seized with sharp pains in the lower back which had prevented his straightening up. Some relief was afforded by having his back strapped. He was disabled for seven days and was discharged by the company physician. His pain continued and he was fitted with a brace which gave some relief. Two months later a roentgenographic examination of the spine made elsewhere was reported as negative. In June, approximately five months later, another roentgenogram at a second clinic gave evidence of fracture. He had relief at times but on exertion the dull, aching pain returned and there was occasional stiffness of the muscles in the left thigh.

The physical and laboratory examinations revealed a moderate prostatitis. There was marked lumbar lordosis with no deviation to either side; no curvatures were demonstrable clinically. Slight tenderness was elicited over the left lumbosacral joint, and over the lower spinous processes with spasm of the muscles on both sides. There was no pain on lifting the legs straight or on spreading and compression of the iliac crests.

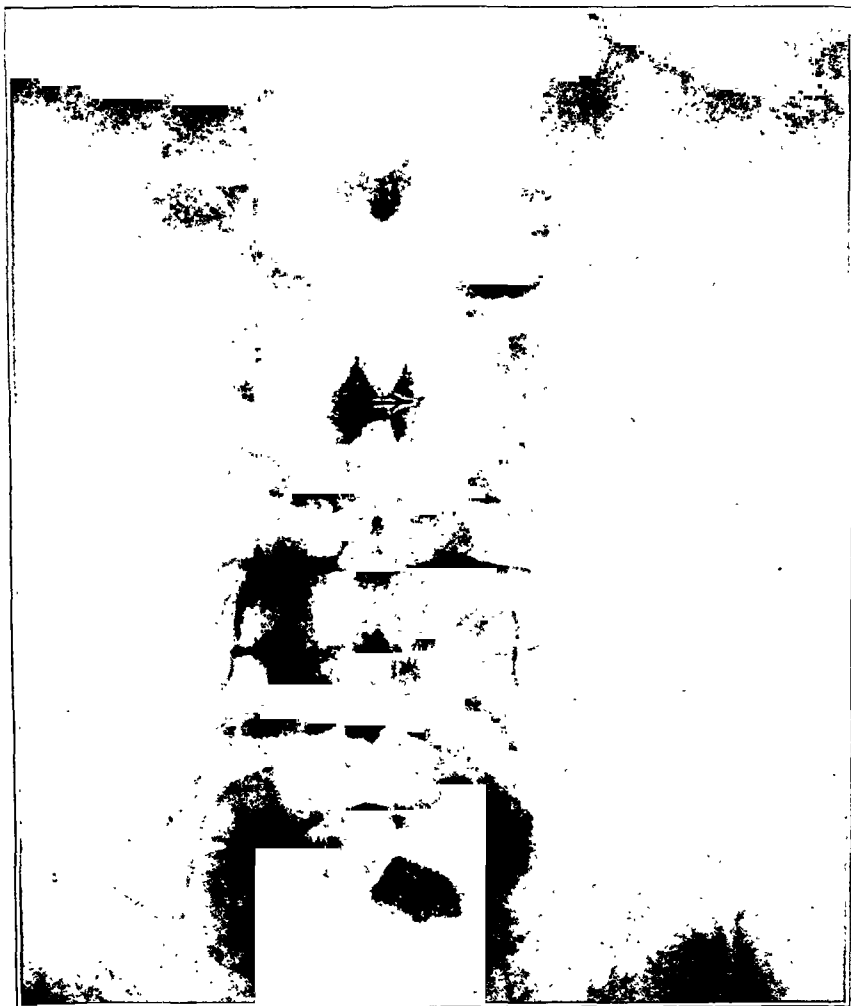


FIG. 4

Case 4. Anomaly of inferior articular process of second lumbar vertebra, left side.

Grating was present in both knee joints, but there was no evidence of abnormality in other joints.

The roentgenogram showed an *incomplete fusion of the inferior articular process of the second lumbar vertebra on the left side and bilateral ribs at the level of the first lumbar vertebra*. There was a left angulation of the lower dorsal spine. The twelfth dorsal and the first lumbar vertebrae were rotated toward the right, and also were wedge-shaped with anterior apices. There was no fracture or other evidence of recent trauma (Fig. 2).

CASE 3. A laborer, aged thirty-one, was observed first in 1925 complaining of "weakness in small of back". He said that he had been thrown from a motorcycle in 1917 while in the army. He had to be relieved of duty periodically because of back discomfort. Since that time he had had persistent pain across the lower back, particularly after activity. This would disappear for two to three weeks, but bending or lifting



frequently caused return of the symptoms which were incapacitating at times. Change of position sometimes gave relief. Physical examination showed moderate lordosis of the lumbar spine with discomfort on hyperextension and considerable spasm of the muscles in the lumbar region; there was marked tenderness over the lumbosacral region and over the spinous processes of the lumbar vertebrae. The roentgenogram showed an incomplete fusion of the inferior articular process of the second lumbar vertebra on the left side and an anomaly of the last segment of the sacrum, failure of fusion of the laminae of this segment, and an anomalous lateral articulation on the right side between the fifth lumbar vertebra and the sacrum. A brace was applied to the back and the patient received considerable relief.

He returned again in 1932 for an examination required by the Veterans Bureau. He had not worn his brace for several years and his discomfort was not so severe as formerly. The lower back was moderately hollow. Movements were good and occasioned only slight discomfort on hyperextension. There was some tenderness over the fourth lumbar spinous process. The presence of the incomplete fusion previously reported was confirmed by roentgenographic examination on his second visit and showed no change in appearance (Fig. 3).



FIG. 5

Case 5. Anomaly of inferior articular process of second lumbar vertebra, right side.

CASE 4. A man, aged thirty-three, came to the Clinic in 1927, complaining of generalized stiffness and soreness, which had begun one month before in the lower back. There was a decrease in libido and the patient had some burning and frequency of urination. He attributed these symptoms to an old Neisserian infection. Physical and laboratory examinations disclosed a chronic prostatitis.

Roentgenographic examination of the lumbosacral region showed an incomplete fusion of the inferior articular process of the second lumbar vertebra on the left side and a calcified mesenteric lymph node in the mid-line opposite the fifth lumbar vertebra (Fig. 4).

CASE 5. A man, forty-four years of age, was observed first in 1931. He complained chiefly of "headaches and lumbago". The patient had always enjoyed fairly good health and was employed as a machinist, but for ten years he had had "pressing" coronal and vertex headaches. He complained of feeling tired in the morning and his memory decreased at times. He suffered from pain in the back, with muscle soreness, and his hands and feet felt cold and clammy.

Physical examination revealed a slight symmetrical enlargement of the prostate,

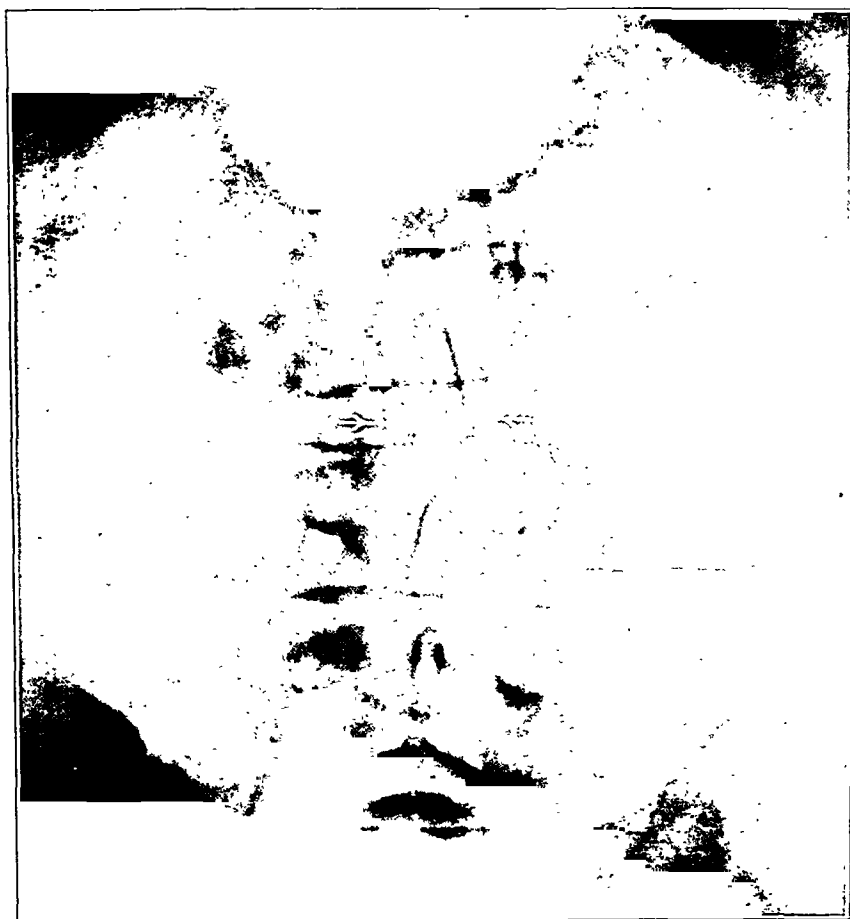


FIG. 6

CASE 6. Anomaly of inferior articular process of second lumbar vertebra, bilateral.

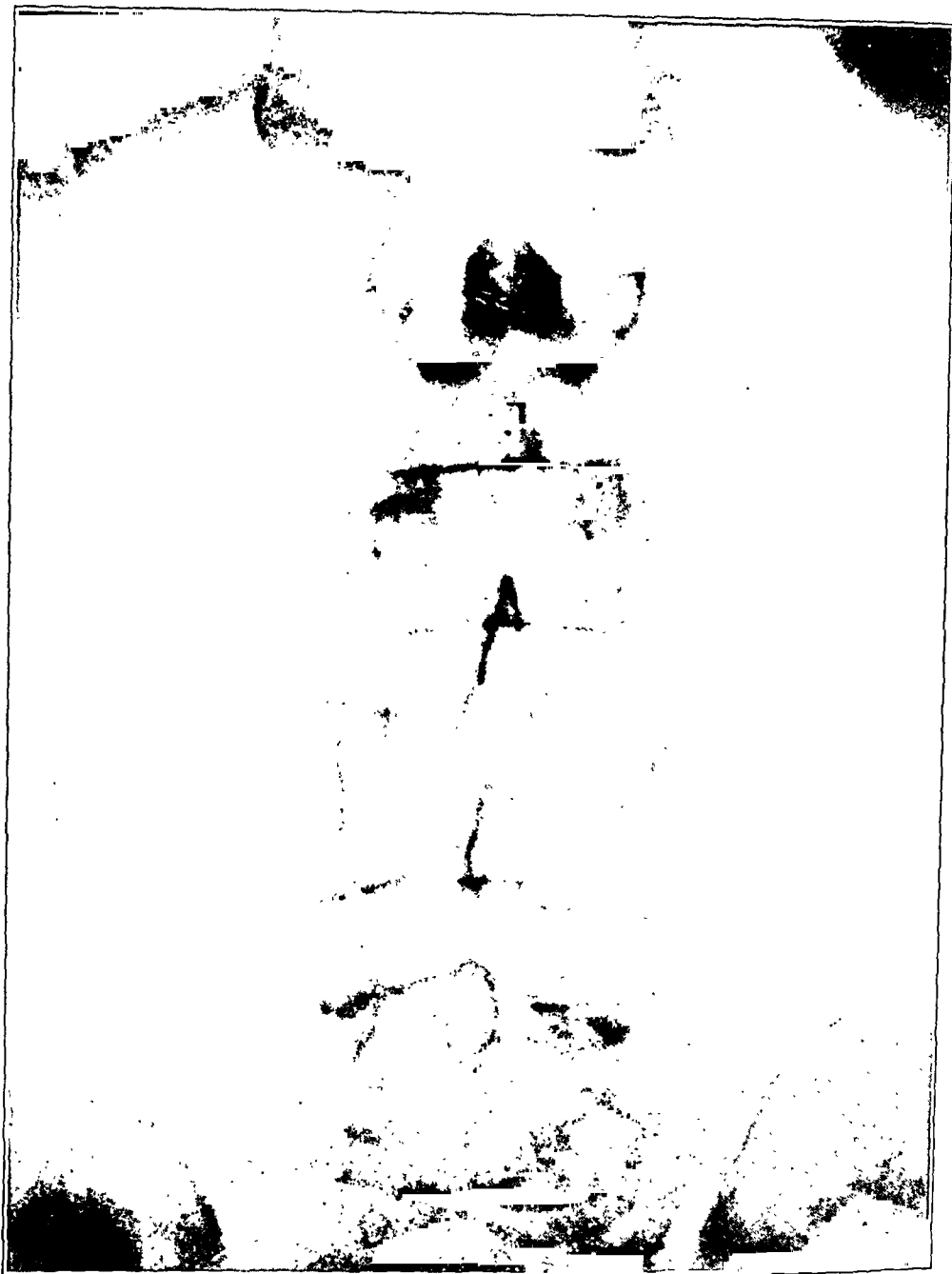


FIG. 7.

Case 7. Anomaly of inferior articular process of second lumbar vertebra, right side.

a typical sacro-iliac arthritis on the right side, slight atrophy of the right thigh, and pain referred to the sacro-iliac region on straight leg raising. The roentgenogram showed some hypertrophic changes in the lumbar spine and an anomaly of the second lumbar inferior articular process on the right (Fig. 5).

CASE 6. A physician, aged fifty-six, presented himself for examination in 1931, complaining of hypertension, dizziness, and urinary difficulties. There was slight lordosis, but the patient did not complain of any pain in the back. Besides the hypertension and enlarged heart, the clinical and laboratory examinations showed gingivitis and dental caries. A roentgenogram of the kidneys, ureter, and bladder was made in

order to rule out the presence of calculi. This showed the bilateral non-fusion of the inferior articular processes of the second lumbar vertebra (Fig. 6).

CASE 7. A man, aged fifty-two, was first observed in July, 1932, complaining of fever with pus in the urine. He had had an "intestinal infection" accompanied by pus in the urine which soon disappeared. Two weeks before admission he had had a chill followed by fever which was relieved by aspirin. The following day his temperature was 102 degrees but this soon returned to a normal level. Since that time he had been free of symptoms but continued to have nocturia two to three times with burning. Physical examination revealed hemorrhoids and retention of some urine (seventy-five cubic centimeters), containing pus. A roentgenogram of the kidneys, ureter, and bladder revealed many phleboliths in the bladder area and an anomaly of the inferior articular process of the second lumbar vertebra on the right side (Fig. 7).

#### ROENTGENOGRAPHIC DIAGNOSIS

It is our practice to make stereoroentgenograms for the study of the spine, as this method has been found superior to examination by single anteroposterior and lateral roentgenograms.

This apparent anomaly has the characteristic appearance of an ununited epiphysis. The linear defect extends from above downward and medially, or it may be almost horizontal, bisecting the inferior articular process. The defect may extend through the facet face, or just above the base of the lamina. Each smooth edge is bordered by an apparently increased bone density as is observed in ununited epiphyses. In our experience the condition has not been observed as involving the superior articular processes.

#### DISCUSSION

This unusual appearance of the inferior articular processes of the lumbar vertebrae is apparently a developmental anomaly. It is impossible to determine whether it represents an anomalous ununited epiphysis or results from atypical ossification after the cartilaginous primordium has formed. Available embryological and anatomical data do not contain a description of separate epiphyseal centers for the articular processes. A roentgenographic diagnosis of ununited epiphysis, therefore, is not justified by present embryological or anatomical records. A non-fusion of the lamina which supports the process has been ruled out so far as is possible with available museum specimens. Confirmation of the roentgenographic findings by autopsy has not been possible.

The chief importance of this anomaly apparently concerns its medico-legal and economic aspect, as the condition may be diagnosed as fracture. Two of the patients reported here had been referred to the Clinic with such a diagnosis.

A review of the histories of these patients discloses no symptoms which can fairly, logically, and definitely be attributed to the specific finding. At times, apparently slight and insignificant developmental defects of the vertebral column, when aggravated by trauma, predispose to back discomfort. Injury is not always a factor, as frequently such persons complain of back discomfort when doing heavy labor, or with

increasing age and weight. Roentgenographic examination reveals no evidence of old or recent bone injury. The disability which may be caused by slight trauma in persons having congenitally unstable vertebral columns has been recognized by industrial companies; and some of them emphasize the importance of the condition to the extent of making a preliminary roentgenographic examination of the spine prerequisite to employment. Such a procedure apparently has been justified by the high incidence of anomalous conditions found in persons thus examined.

Although most of the patients in this group complained of some pain or stiffness in the lumbar or sacral region, a review of the case histories does not justify the assumption that these symptoms were due to the non-fusion of the inferior articular process of the lumbar vertebrae. The co-existence of hypertrophic arthritis or of foci of infection, such as prostatitis, and the history of back strain incident to trauma might explain all the symptoms of which these patients complained. However, it is possible that slight trauma may cause more discomfort in a patient with anomalous vertebrae than would be occasioned by the same injury in a normal person.

#### SUMMARY

An unexplained incomplete union of the inferior articular processes of the lumbar vertebrae is presented. This has the typical roentgenographic appearance of an ununited epiphysis. Separate epiphyses for the articular processes are not described in the present texts of embryology or anatomy or in the available literature. This condition has been illustrated and described in detail, because it may assume medico-legal significance when misinterpreted as fracture. When one becomes familiar with the typical roentgenographic appearance, the condition offers no diagnostic difficulties. We believe this is an ununited epiphysis, probably anomalous, of the inferior articular process of the lumbar vertebrae. As stated before, embryological confirmation is lacking. It seems logical to assume that the anomaly is not responsible for the symptoms present in the cases described.

We wish to express our appreciation to Harvey E. Jordan, M.D., Professor of Histology and Embryology, University of Virginia, for his kindness in reviewing his records in an effort to establish the embryological and anatomical nature of the condition described.

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## FRACTURES OF THE OLECRANON

BY ERNEST M. DALAND, M.D., BOSTON, MASSACHUSETTS

*From the Fracture Service of the Massachusetts General Hospital*

For several years all cases of fractures treated in the wards of the Massachusetts General Hospital have been sent for at the end of a year in order to determine the end results of treatment. Patients coming to this clinic are seen by a group of men, carefully examined, any disabilities noted, and final x-rays are taken. With the old and new x-rays at hand a rating is made of the success or failure of the treatment given,—this rating based on anatomical, functional, and economic factors. For brevity these factors are spoken of as the “A”, “F”, and “E” end results. The degree of perfection in each group is rated on a one, two, three, or four basis; one is from no per cent. to twenty-five per cent., two from twenty-five per cent. to fifty per cent., three from fifty per cent. to seventy-five per cent., and four from seventy-five per cent. to one hundred per cent. An “A<sup>3</sup> F<sup>4</sup> E<sup>3</sup>” result would indicate that the anatomical result based on length, alignment, apposition, and angulation was from fifty to seventy-five per cent. perfect; the functional result based on the patient’s ability to use the fractured bone and the neighboring joints was seventy-five to one hundred per cent. perfect; and the economic result based on the patient’s ability to do the same work for the same length of time at the same wages was fifty to seventy-five per cent. perfect.

This study is based on forty-eight cases of fracture of the olecranon. Twenty-four were treated in the House and followed for about a year. Nine cases similarly treated were not seen to determine the final result. Fifteen cases were given first-aid treatment in the Emergency Ward, but not followed in the House afterward. Data on the last group are very incomplete, so that we have eliminated these cases from detailed study.

The epiphysis of the olecranon process appears at the age of eight and becomes fused at sixteen. It is rarely separated but the normal epiphyseal line is sometimes mistaken for a fracture line. In a patient under eight a fracture line must not be mistaken for the epiphyseal line, however.

Fractures of this bone may occur at any age, but are most common in the first three decades. In our series of forty-eight cases, the ages ranged from three to sixty-nine. Eight fractures occurred in children under eight,—before the appearance of the epiphysis; eleven occurred between eight and sixteen,—before the fusion of the epiphysis to the diaphysis; and twenty-nine after fusion.

These fractures are caused by direct trauma or by falls on the out-stretched hand with the elbow partially flexed. During flexion the triceps is tight and the blow is transmitted through the lower arm and the sigmoid fossa to the olecranon against the tense muscle. We have data on

the type of injury in thirty-eight cases and in these there are four instances of a direct blow to the olecranon. Ten patients fell from a height; eight fell from moving autos or motorcycles; and seventeen received their injuries by falls to the floor, street, or ice. It is uncertain how many actually fell on the outstretched hands and how many struck the elbow directly. Three fractures were compound, but two of these were given emergency treatment only. The other remained infected in spite of careful débridement, but finally healed with a good result.

Examination of an elbow in which the olecranon is fractured and the fragments separated shows localized tenderness and swelling with crepitus. It may be possible to demonstrate a cleft between the fragments. There is pain on motion at the elbow and inability to fully extend the forearm.

Many fractures of the olecranon were associated with other injuries to the bones of the same arm. The most important of these were fracture or dislocation of the head of the radius (seven cases), greenstick fracture of both bones of forearm, fracture of the coronoid process of the ulna, fracture of the lower end of the ulna, fracture of the capitellum, and fracture of the surgical neck of the humerus (two cases).

#### TREATMENT

Fractures of the olecranon are the only fractures about the elbow which should be treated in extension. The olecranon fossa of the humerus is just deep enough to give full extension of the arm when the ulna is of normal length and any increase in length must necessarily decrease the degree of extension. Hence complete reposition of the fragments and retention in good position are of vital importance.

In our series there were five cases where the fracture was trivial or where displacement had not occurred; so that no treatment other than a sling or a Lund swathe was needed. Four others were untreated, two because of other injuries more serious than the olecranon and two because

TABLE I  
METHOD OF TREATMENT OF THIRTY-THREE HOUSE CASES  
FRACTURE OF OLECRANON

	<i>With End Results</i>	<i>Without End Results</i>
No treatment . . . . .	2	2
Plaster or bandage in extension . . . . .	1	1
Manipulation and plaster . . . . .	1	3
Unsuccessful manipulation and later operation—3		
Operative fixation with catgut . . . . .	3	
“ “ “ wire, nail, or bone peg . . . . .	4	
“ “ “ Kangaroo tendon . . . . .	2	
“ “ “ “ “ and fascial plaque . . . . .	4	1
“ “ “ fascial suture . . . . .	7	2
	—	—
	24	9

of refusal of treatment. The other was an old fracture complicated by fracture of the head of the radius. In this case the radial head was removed but the olecranon was not treated.

Manipulation under an anaesthetic occasionally gives a good reposition of the fragments, so that fixation may be maintained by the application of plaster to the arm in extension. Of the Emergency Ward cases, seven were treated in this way, but we do not know the results. Of four House cases so treated, one is untraced; one had a good result but showed some deformity of the olecranon; a third was treated in a cast without manipulation because skin injuries made operation impossible, but a perfect result was obtained in eight weeks; a fourth sustained a refracture and an open operation was necessary. Two other cases were put up in plaster at a right angle, but the final results in these two are unknown.

Manipulation and application of a cast failed to give a proper reduction in six cases and operation was required. Six failures out of seven attempts are sufficient evidence of the inefficacy of this method.

Open operation is the proper treatment for any fracture of the olecranon in which there is any displacement of the fragments. We have tried many methods and we are now agreed that the best method is suture of the fragments with strips of fascia lata. If motion is to be started early, suture or fixation material stronger and more lasting than catgut must be used. We shall review our experiences with the different methods.

#### *Chromic Catgut Suture*

In three cases the fragments were brought into alignment by direct vision. They were held in position by chromic catgut sutures to the torn fascia and the arm placed in extension in a plaster cast. One of these fractures was compound and after débridement and suture was held by an anterior plaster splint. The arms were kept in extension for three weeks, but the casts were bivalved and massage started in about ten days. Flexion was started after three weeks. One patient returned to his regular duties as a fisherman at the end of a month. All three cases were rated as perfect end results. The period of disability in the compound fracture was three months and in the others it is not known.

The chief objection to catgut suture is the longer period of immobilization required, because of the weakness of the suture material and the danger of separation of the fragments as the catgut softens. Early motion is very much to be desired in this type of fracture and the final result depends as much on this as on the operation. Early motion cannot be started if catgut is used for the suture material.

#### *Nails, Wire, Beef-Bone Pegs*

In the effort to secure a stronger type of suture or fixative, various materials have been tried out. Three cases were treated by metal fixatives and one by a bone peg.

A boy of seventeen was operated on for a dislocation of the head of



the radius, a fractured olecranon, and a fractured ulnar shaft. The olecranon fragments were held together by four strands of Vienna braided wire. The patient returned to his former work as a shoe-machine operator, but he never regained the last ten degrees of flexion. The wire has not been removed.

A woman of thirty-one was treated by the insertion of a flanged nail through the bony fragments. She returned to full duty in five weeks and secured a perfect result. The nail has been removed.

A man of sixty-nine, suffering also from a fractured femur, was operated on under novocain and a double mattress suture of silver wire was used. A month later, under gas-oxygen anaesthesia, the wire was removed and bony union found. A week later he developed facial erysipelas, recovered, but died two months after operation of coronary thrombosis. In this case the second operation required to remove the foreign body may have been a factor contributing toward death.

A woman of fifty-two was operated on and a beef-bone peg driven through holes in the two fragments. Her disability was for three months, but she secured a perfect result.

In the case of another man of twenty-seven, heavy wire was used at a secondary operation which was necessitated by the separation of the fragments, which had been held together by kangaroo tendon. Three months later the patient fell and broke the wire. Braided bronze wire was then used together with a fascial suture. The result was satisfactory except for limited flexion.

#### *Kangaroo Tendon*

Kangaroo tendon was used alone in one other case besides the last one cited. This was in a child of five and was complicated by a fracture of the neck of the radius which was impacted. The head was replaced; the olecranon was held by two kangaroo sutures passed through the triceps tendon and the ulnar shaft; and the arm was put up at a right angle. The result was not good. A bone synostosis developed between the radius and ulna at the upper end and there was interference with growth about the elbow. Whether or not there was any lengthening of the ulna was uncertain.

#### *Kangaroo Tendon and Fascia Lata Placque*

In five cases kangaroo tendon was used as the suture material. It was passed through holes bored in the two fragments. In addition, the repaired triceps tendon was reenforced by a placque of fascia lata, sutured above and below the tear in the tendon.

A man of fifty, who developed sepsis after operation, developed a stiff elbow at one hundred degrees of extension. He was able to work regularly at his old job as a painter, but received a rating of zero for his anatomical end result.

A man of fifty-six was given an anatomical rating of three because he showed a final irregularity in the outline of the olecranon. He was able

to do his former work, although he lacked five per cent. of full extension.

A boy of nineteen returned to his work of driving a heavy truck five weeks after injury and four and one-half weeks after operation. The result was perfect.

Another boy of thirteen received a refracture after treatment in extension and was operated on according to this method with a perfect result.

The result of the other case is not known.

Active motion was allowed from the start in one case and at the end of a week in a second case. In the other cases the arms were splinted at right angles and in these motion was not started as early.

### *Fascia Lata Suture*

Fascia lata was used as the suture material in nine instances. The use of fascia lata in this way entails no more operative work than in the method last described. The advantages are that fascia lata is a living suture of great tensile strength. Barring sepsis, it can be counted on to hold the fragments in the position where the operator places them. Early, active motion can be started without fear of complications. As a rule, motion is allowed by the third or fourth day,—as soon as the trauma of operation has disappeared.

A longitudinal incision is made over the olecranon, exposing the triceps tendon above and below the line of fracture. The skin flaps are retracted laterally, exposing the transverse tear in the triceps. The bone fragments are then exposed and any clots removed from between the ends. One drill hole (five millimeters) is made in each fragment, extending obliquely into the line of fracture and great care is taken that the articular surface is not injured. A strip of fascia lata, three centimeters by about twenty centimeters, is taken from the thigh and passed through these holes according to the technique described by Allen.<sup>1</sup> The fascia is rolled to enable the operator to pass it through the holes in the bones. The fragments are pulled together and the ends of the fascia are unrolled. One end of the fascia is brought through an opening in the other and the unrolled ends are sutured to the triceps fascia. In this way, retention of the fragments is secured with a living suture and also the torn triceps tendon is reenforced with a fascial graft. The wound is closed without drainage.

In examining the results of these operations, we find that a perfect rating has been given in all but one of seven cases followed to a final result. This one patient also had a fracture of the surgical neck of the humerus which responded well to treatment. However, after leaving the Hospital, he went to another where the fragments of the olecranon were removed for some unknown reason with the result that his arm was a very poor one with no motion at the elbow. He was given a fifty per cent. economic rating.

In this group we find four children between ten and sixteen, three

TABLE II  
FRACTURES OF OLECRANON  
END RESULTS OF TWENTY-FOUR HOUSE CASES

Case No.	Age	Method of Reduction	Fixative	Position	Disability	Rating AFE	Comments
W 276613	8	None	None	—	?	334	Untreated.
O 305174	57	"	"	—	?	333	"
W 265313	8	Manipulation	Plaster	Extension	?	344	Deformity of olecranon.
E 300855	22	None	"	"	8 weeks	344	Poor skin condition at entrance.
E 258293	30	Open operation	Chromic catgut	"	4 weeks	444	
E 264345	9	" "	"	"	12 weeks	444	Compound fracture.
O 279207	69	Manipulation, then open operation	"	"	?	444	
E 269902	17	Manipulation, later open operation	Wire	Right angle	?	344	Lacked 10 degrees of full flexion.
O 275844	31	Open operation	Flanged nail	"	5 weeks	444	
O 274887	69	" "	Wire	Neutral	—	—	Died: coronary thrombosis.
O 307270	52	" "	Bone peg	Right angle	12 weeks	444	
W 262165	27	" "	Kangaroo tendon, then wire on two occasions	Extension	40 weeks	334	Broke wire.
W 305612	5	" "	Kangaroo tendon	Neutral	?	224	Complicated by fracture of neck of radius.
W 298276	50	" "	Kangaroo tendon. Fascial plaque	Right angle	14 weeks	004	Sepsis.
W 279455	56	" "	"	"	?	344	Lacked 5 degrees of full flexion and extension.
W 270736	19	" "	"	"	5 weeks	444	
E 288836	13	Manipulation and later open operation	"	Neutral	12 weeks	444	
E 266032	16	Open operation	Fascia lata suture	Right angle	8 weeks	444	
O 301712	39	" "	"	Extension	12 weeks	444	
W 267647	10	" "	"	"	?	444	
O 286011	11	" "	"	Right angle	4 weeks	444	
E 304234	61	" "	"	Neutral	4 weeks	444	
O 292387	28	" "	"	Extension	?	202	Also fracture of surgical neck of humerus. Fragments of olecranon removed at another hospital after discharge.
W 301491	14	" "	"	Right angle	3 weeks	444	

boys and a girl. Three arms were put up at a right angle after operation and the other in extension. All of these fractures were uncomplicated and the longest disability was eight weeks. Two other patients, aged thirty-nine and sixty-one, did equally well. Because of the accurate approximation and firm retention of the fragments and the early starting of motion, none of these had any limitation of motion.

The period of disability is known in five cases; it ranged from three to twelve weeks, with an average of six weeks.

#### *Anaesthesia:*

Ether was used for the primary manipulation in all the cases (seven). For the open operation the anaesthetic was ether in seventeen cases, gas oxygen, novocain, and ethylene, each twice.

#### *Period of Disability:*

The period of disability was determined in fourteen cases, and varied from three weeks to forty weeks. If we exclude the septic case and the case with two breaks of the wire suture, the average disability of the other twelve cases was seven and four-tenths weeks.

### SUMMARY AND CONCLUSIONS

1. A statistical study is made of forty-eight cases of fracture of the olecranon with end-result studies in twenty-four. Fifteen of these cases were treated in the Emergency Ward and were not admitted to the House.

2. Closed reduction of these fractures has been very unsatisfactory and we believe that it is not worth attempting. Open operation is indicated whenever there is any separation of the bone fragments.

3. The results of open operation by any one of five methods have been universally satisfactory. The only unsatisfactory cases have been one complicated by postoperative sepsis and another complicated by an ill-advised secondary operation done elsewhere. The operation calls for exact reposition of the fragments and fixation by catgut, wire, kangaroo tendon, nails, pegs, or fascia lata. The use of foreign bodies as fixatives means secondary operations for their removal.

4. The operative mortality was four and three-tenths per cent. in the twenty-three cases on whom open operations were done.

5. There is no relation between the age groups or the degree of development of the epiphysis and the final result.

6. From our tabulated results it is not possible to demonstrate any quicker recovery from the use of any one material, but from personal observation we are convinced that function returns faster and the final elbow is stronger when fascia lata is used as a living suture to hold the fragments together. This is the method now in use at this hospital and the method which we wish to recommend.

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# ISOLATED FRACTURES OF THE ARTICULAR PROCESSES OF THE LUMBAR VERTEBRAE \*

BY C. LESLIE MITCHELL, M.D., DETROIT, MICHIGAN

Although fractures of the articular processes, associated with severe fractures and fracture dislocations of the vertebrae, are frequently seen and reported, very little mention has been made in the literature of an isolated fracture of this process. The present series of cases observed in a comparatively short period of time leads the writer to the belief that the fracture is not at all uncommon and frequently accounts for long-continued back symptoms following a severe injury.

Since the first case came under the writer's observation early in 1929, he has been constantly on the lookout for this type of fracture, particularly in those patients who have had a severe back injury, apparently negative roentgenographic findings, and yet prolonged symptoms that did not respond to the usual treatment for low back sprain. In several cases it was only after repeated x-ray films from different angles and with finer detail that the lesion was discovered. Of the present series of five cases, four were personally observed by the writer and the other is reported through the courtesy of Dr. C. W. Brainard of Battle Creek, Michigan.

Brief mention of this fracture is made in the literature and in textbooks by many different authors, but there are very few specific cases cited. Burk <sup>1</sup>, in 1908, reported a fracture of the superior articular process of the fifth lumbar vertebra. Koch <sup>2</sup>, in 1923, brought the literature up to date in a report of a single case with a fracture of the inferior articular process of the fourth lumbar vertebra and the superior process of the fifth.

The fractures observed in this series have all involved the processes of the lumbar vertebrae, but it is conceivable that a similar lesion of the thoracic and cervical vertebrae could occur. The difficulty in obtaining satisfactory roentgenographic detail of the processes of the latter vertebrae may account for the non-recognition of similar fractures there. Anatomically, however, there is much greater chance for these fractures to occur in the lumbar spine than elsewhere.

It is the writer's opinion that these fractures occur as a result of indirect violence. A severe force, causing the spine to be flexed both forward and laterally and at the same time rotated, produces impingement of the subjacent articular processes. The capsules, which are attached to the margins of the articular processes, are placed under considerable tension. If the force is sufficient, the combined action of impingement and capsular pull will produce a fracture of the tip of one or both of the subjacent processes.

An interesting feature in all of the cases observed is the persistent non-union of the fragments with no attempt at callus formation. This has

\* From the Division of Orthopaedic Surgery, Henry Ford Hospital, Detroit.

been the observation of all writers on the subject. It is possible that incomplete immobilization of the fragments and the presence of synovial fluid may account for this failure of bony union. All of the fractures observed in this series, and by other writers, have been recognized late following the injury, and to the writer's knowledge there is no report of an early diagnosis with complete immobilization.

It might be argued that these lesions do not represent fractures but rather developmental anomalies with failure of union between the primary and secondary epiphyseal centers. According to McMurrich<sup>3</sup>, secondary centers of ossification appear at puberty in the cartilage at the tips of the articular processes. These epiphyses remain separate until growth is complete and between the sixteenth and twenty-first years unite with the bone from the primary center. No such anomalous lesion has, to the writer's knowledge, been described in the literature. Willis<sup>4</sup>, in a study of 1471 skeletons in regard to vertebral anomalies, does not mention this lesion. Furthermore, one would expect to encounter this lesion quite frequently in routine roentgenograms of the spine, but we have no knowledge of its occurrence without a history of severe trauma. There was point tenderness over the fractured processes in all of the cases observed. Three of the cases in this series presented double lesions and these were all unilateral, suggesting a traumatic etiology. Trauma as an etiological factor is again suggested by the fact that all five patients were males. In the case operated upon by the writer, the processes were exposed and fibrous tissue union found between the fragments. Microscopic study of the intervening tissues showed no evidence of cartilage, as would be expected with a failure of union between the epiphyses.

Eight fractured processes are included in this series as three patients exhibited double lesions. An analysis of the lesions reveals that five of the fractures involved inferior processes. The processes of the second, third, and fourth lumbar vertebrae only were involved, possibly due to limited mobility in this region as compared with the dorsolumbar and lumbosacral joints. The location of the fracture line varied from three-tenths to one and two-tenths centimeters in distance from the tip of the process.

Conservative treatment gave satisfactory results with three patients who were first observed some months following injury. Treatment consisted of a short period of recumbency, followed by physiotherapy and the application of a support,—such as a canvas belt or a Goldthwait back brace.

Two patients did not respond to conservative treatment and in these cases a spinal fusion was performed. At operation the involved processes were exposed, the fractured tips and the cartilage of the facets removed, and a tibial graft placed between the split spinous processes. Immediate relief of symptoms was noted in both cases following operation; and one patient (W. C.) has had no recurrence of symptoms ten months later. The other patient (H. W.) has remained symptom-free since his operation three months ago.

## CASE REPORTS

CASE 1. Mr. W. C., thirty-nine years old, was injured on November 24, 1928, while unloading lumber from a flat car. He was struck by a crane load of lumber and knocked off the car, falling ten feet to the ground, and landing on his left side. He was brought to the hospital by ambulance and seen by the writer on admission. His symptoms were referred to the left hip and roentgenographic examination revealed an intertrochanteric fracture of the femur without displacement.

In February, 1929, when commencing to walk, he complained for the first time of

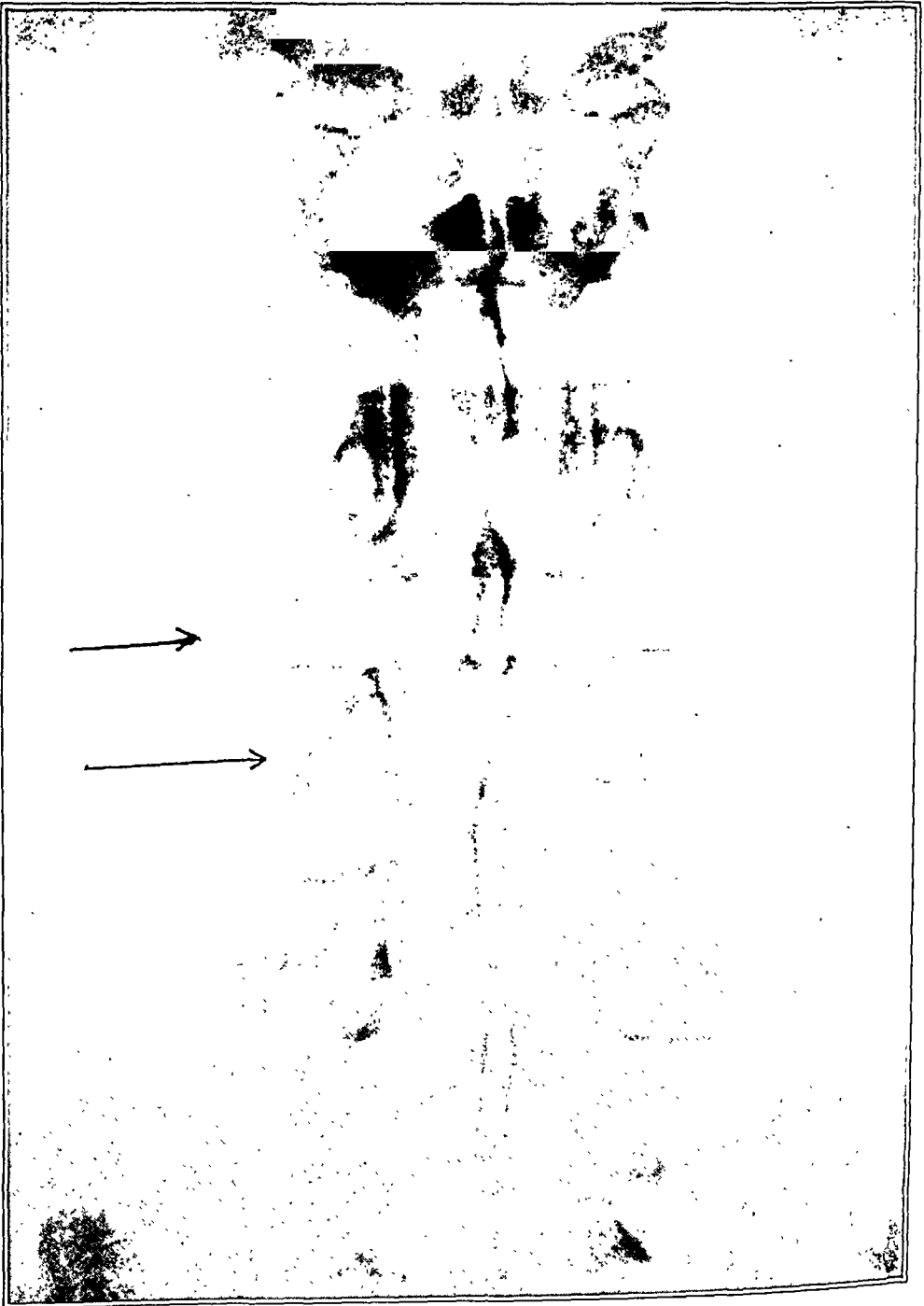


FIG. 1  
Case 1.

symptoms in the low back region. Examination of the spine revealed moderate restriction of motion of the lumbar spine in all directions and it was found that forward flexion and rotation counter-clockwise produced pain, referred to the right side of the spine at the level of the third and fourth lumbar vertebrae.

Roentgenograms were taken of the lumbar spine and pelvis and no evidence of pathology was found. A diagnosis of low back strain was made and the patient treated with physiotherapy and a lumbosacral belt. Because of continuation of symptoms, detailed roentgenograms of the lumbar spine were repeated on April 24, and these revealed a fracture of the superior articular process of the fourth and the inferior process of the third lumbar vertebrae on the right side.

A Taylor back brace was applied and physiotherapy to this region continued. He returned to light work in May, 1929. Progress roentgenograms, taken at intervals until February, 1931, revealed no evidence of callus formation and the patient continued to complain of discomfort in this region. Operative fusion of this area was advised and performed on May 14, 1931.

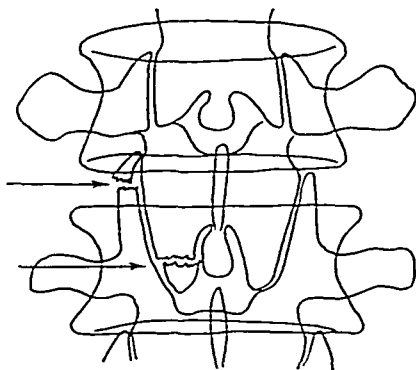


FIG. 2

Case 1. Schematic drawing of Fig. 1.

At operation, the laminae and articular processes of the third and fourth lumbar vertebrae were exposed. The tips of the superior process of the fourth and of the inferior process of the third on the right side were easily visualized and found to be partially detached. There was fibrous tissue only between the fragments and no evidence of callus or cartilage. The fractured tips were excised, the cartilage from the articular surfaces removed, and an Albee fusion of the second, third, fourth, and fifth lumbar vertebrae carried out. Microscopic examination of the tissue between the fragments revealed fibrous tissue only and no evidence of cartilage.

Patient had complete relief from back symptoms following the operation. He was allowed up in June and had no further trouble until September, when he reported back with recurrence of symptoms. On examination it was found that the distal portion of the graft had become loose. The spine was re-fused in March, 1932, and he has remained symptom-free since then.

**CASE 2.** Mr. N. W., seventeen years of age, was admitted to the hospital on May 21, 1931. Three months previously he had injured his back in a fall of about six feet from a trapeze bar. He had noticed pain in the back for several weeks following the accident, but was not disabled. On several occasions since then he had experienced pain in this region after severe exercise, usually accompanied by pain in the right lower abdominal quadrant.

He was admitted on the General Surgical Service with a complaint of pain in the right lower abdominal quadrant of two days' duration. For the past six hours he had also noticed pain in the low back region. There was no history of nausea or vomiting. Temperature was 98.8 degrees; white blood cells 8,350. Urinalysis was negative. There was tenderness in the right lower abdominal quadrant but no muscle spasm.

Roentgenograms of the lumbar spine revealed fragmentation of the left inferior processes of the second and third lumbar vertebrae. Examination of the spine showed flattening of the lumbar curve, marked limitation of motion of the lumbar spine, and tenderness on pressure over the laminae of the second and third lumbar vertebrae on the left side. Pain in the back was produced by forward flexion and rotation of the spine clockwise.

Appendectomy was performed on May 23, with a pathological report of chronic appendicitis. A Taylor back brace was applied prior to discharge from the hospital on



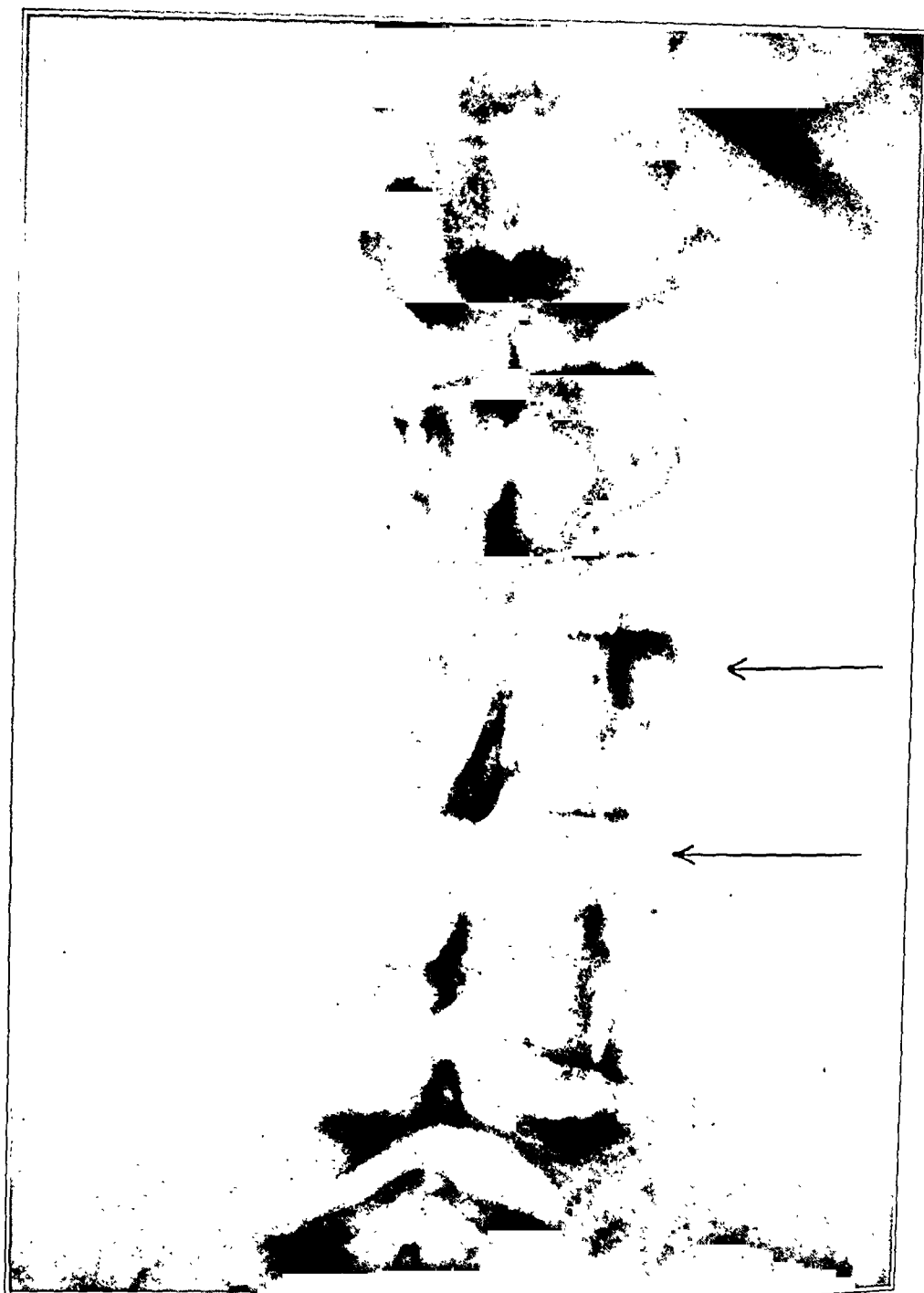


FIG. 3  
Case 2.

June 7. When he was last seen in October, 1932, the spine was symptom-free but there was still palpatory tenderness over the fractured processes. Progress roentgenograms revealed no evidence of callus formation.

CASE 3. Mr. F. D., forty-five years of age, was first seen in the hospital in October, 1926. He gave a history of a severe injury to his spine twenty years previously with disability for about three weeks. Since that time he had had recurrent attacks of acute low back discomfort at irregular intervals, always following severe exertion.

Examination revealed a total list of the spine to the left, flattening of the lumbar spine, with spasm of the erector spinae muscles in this region. There was tenderness to percussion over the upper lumbar vertebrae. Roentgenograms were advised, but refused by the patient. A diagnosis of acute lumbosacral strain was made and adhesive strapping applied with relief from symptoms in about three days' time. In June, 1930, he reported back with similar symptoms and findings. Adhesive strapping gave relief from symptoms in a few days' time.

He was seen by the writer in April, 1932, with a complaint of symptoms in the low back of three months' duration. The symptoms had occurred suddenly at that time while lifting a hundred-pound sack of flour. Examination revealed a total list of the spine to the left, flattening of the lumbar spine with muscle spasm, and point tenderness over the lamina of the second lumbar vertebra on the right side. Roentgenograms showed a fracture of the right inferior articular process of the second lumbar vertebra. The fracture line was smooth and there was no evidence of callus formation.

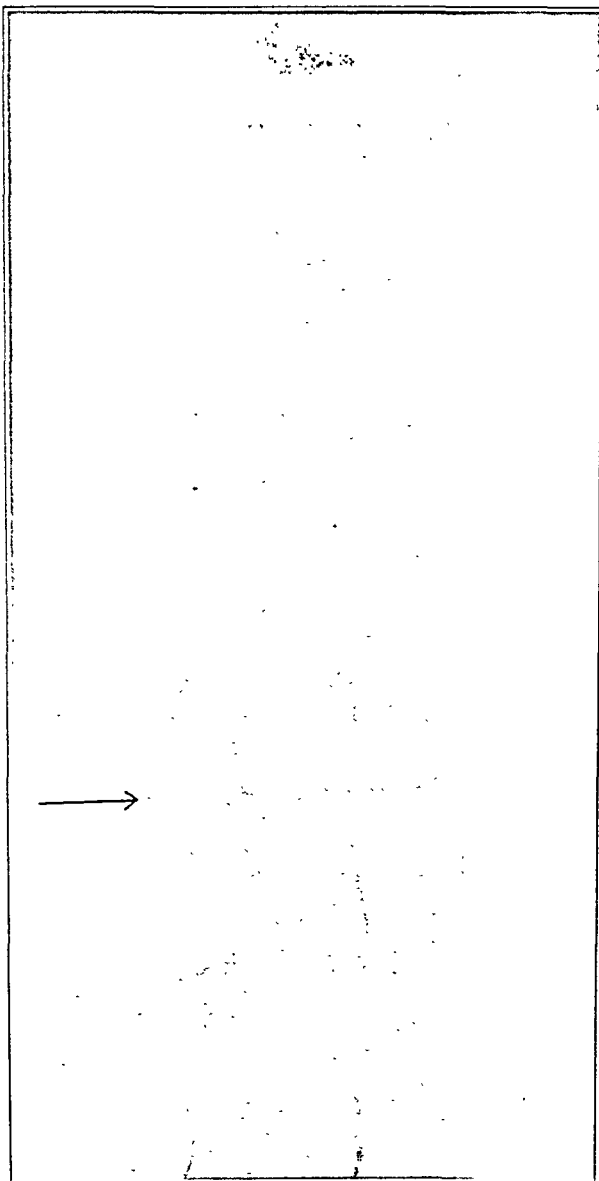


FIG. 4  
Case 3.

A Goldthwait back brace was applied with complete relief from symptoms one week later. A recent letter from the patient states that he has had no recurrence of symptoms since then.

CASE 4. Mr. H. W. (Dr. Brainard's case), truck driver, twenty-five years of age. On February 3, 1932, while lifting a bag of sugar, weighing 100 pounds, from a truck, he slipped on the ice and fell with the bag of sugar striking on his back and right side, about the level of the upper lumbar vertebrae. He noticed back pain immediately but continued at his work, although he was unable to do any heavy lifting. However, his back became increasingly painful and he was seen by Dr. Brainard on February 25.

Examination revealed a list of the spine to the right with flattening of the lumbar curve and spasm of the lumbar erector spinae muscles. Flexion of the spine was possible upon encouragement, with pain always referred to the region of the second lumbar vertebra on the right side. There was tenderness to percussion over this area. Examination by x-ray revealed a fracture involving the right inferior articular process of the second lumbar vertebra.

He was treated by recumbency on a Bradford frame for six weeks. Progress roentgenograms showed no evidence of callus at the fracture site. A Taylor back brace was applied and he was gradually allowed up and about. Because of persistent pain, operation was performed on November 16, 1932. An arthrodesis of the involved articulations was carried out, the fractured tip removed, and a tibial graft placed between the split spinous processes of the second, third, and fourth lumbar vertebrae.

He has been quite comfortable since the operation and the pain, of which he had complained since the accident, has entirely disappeared.

CASE 5. Mr. C. D., twenty-six years of age, was injured on September 25, 1931. A tractor, which he was driving, upset and he was struck forcibly in the right lumbar region by one of the fenders. He was taken to a hospital in Ypsilanti, where he remained in bed for two weeks. Roentgenograms were taken of the lumbar spine and reported negative for fracture. Following his discharge from the hospital, he continued to notice pain in the low back and was unable to return to work. He received some relief with physiotherapy and adhesive strapping, which were given him at intervals for a year.

He was referred to the Henry Ford Hospital for examination on December 1, 1932. He was complaining of pain in the right lumbar region, which was noticed with any bending or twisting of the spine. Examination revealed a slight list of the spine to the right and some loss of the lumbar curve. There was no muscle spasm and forward flexion was not limited, but was carried out guardedly by the patient. Lateral flexion to the left produced pain, referred to the right side at the level of the second lumbar vertebra. There was tenderness to pressure over the articular processes of the second and fourth lumbar vertebrae on the right side. Roentgenograms revealed fractures of the right superior processes of the second and fourth lumbar vertebrae.

A Goldthwait brace was applied and operative fusion recommended, if his symptoms continued. He reported two weeks later, having noticed moderate improvement in symptoms, and has not been seen since then.

#### SUMMARY

1. Attention is called to the isolated fractures of the articular processes of the lumbar vertebrae.

2. This fracture is frequently unrecognized because of imperfect roentgenographic detail, and the patient is frequently treated for low back strain.

3. The possibility of this condition representing a developmental lesion is discussed.

4. For those cases that do not respond to conservative treatment, operation is advised, including spinal fusion, arthrodesis of the involved joint, and removal of the fractured fragments.

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# ROENTGENOGRAPHIC FINDINGS IN ACUTE GONOCOCCAL SYNOVITIS OF THE KNEE TREATED BY PNEUMARTHROSIS

A REPORT OF TWO CASES WITH A PLEA FOR EARLY MOTION \*

BY SIDNEY GINSBERG, M.D., NEW YORK, N. Y.

The introduction of gas into the knee for the purpose of aiding the roentgenographic diagnosis of disorders of that joint has been utilized by a number of writers. Cases of injured semilunar cartilage in which the diagnosis was facilitated by such procedure were reported by Kleinberg <sup>1,2</sup> and Rechtman <sup>3</sup>. Krida <sup>4</sup> described a case of chronic synovial hyper-



FIG. 1

Case 1. Roentgenogram during the height of the first effusion. The effusion, which subsequently forms the organized prefemoral mound, is seen lying against the femur in the ballooned suprapatellar pouch. No air is observed in the posterior joint space and but little in the lateral aspects of the suprapatellar pouch. The ligamentum mucosum is excellently outlined. Due to the accidental injection of air into the soft tissues, the patellar ligament and quadriceps tendon are well visualized.

\* From the Third Surgical Division of Bellevue Hospital, Dr. Arthur M. Wright, Director; and from the Orthopaedic Service of Dr. H. Finkelstein, Hospital For Joint Diseases.



FIG. 2

Case 1. Roentgenogram at end of the first effusion and during the period of immobilization. The increased density of the effusion in the posterior portion of the suprapatellar pouch suggests beginning organization. As yet no air is visualized in the popliteal bursa or in the lateral aspects of the suprapatellar pouch.

trophy of the suprapatellar pouch, the recognition of which was aided by this method. Oxygen was the gas used by these men.

Others have reported the therapeutic insufflation of gas in the treatment of disease of this joint. Rost<sup>5</sup> mentioned five cases of tuberculosis of the knee with good functional results following irrigation and oxygen inflation. Porter and Rucker<sup>6</sup> presented five cases of acute gonococcal synovitis with no functional limitation after treatment by air injection. A case of limitation of motion at the knee following rheumatic polyarthrititis treated in like manner by Henson<sup>7</sup> showed great improvement.

In two cases of acute gonococcal synovitis of the knee joint treated by us, in a manner modifying the procedure of Porter and Rucker, interesting roentgenographic findings were discovered. These indicate an exact anatomical cause of the functional impairment often following this condition and suggest radical changes in the heretofore accepted treatment of the disease.

These cases were observed concurrently. The effusion in Case 1 was continuous for five days and then, after seventeen days of quiescence, recurred for three days more. In Case 2 the effusion was continuous for



FIG. 3

Case 1. Roentgenogram after subsidence of the second effusion and during the period of active motion. The adhesion between the anterolateral aspect of the suprapatellar pouch and the prefemoral mound of organized effusion is clearly shown. The posterior joint space and lateral aspects of the suprapatellar bursa are ballooned by the injected air for the first time.

twenty-three days. Treatment was instituted in both cases within three days of the inception of the disease. The joints were aspirated and inflated with from 120 to 140 cubic centimeters of air daily for as long as the effusion tended to recur. In Case 2, owing to the gelatinous consistency of the effusion, the treatment was supplemented by daily irrigation of the joint with warm saline solution.

No attempt was made either to sterilize or filter the injected air, since no untoward results had been reported in similar instances, nor in the intraspinal injection of air used in encephalography. Injection was performed by means of an aspirating needle and a twenty-cubic-centimeter glass syringe, with a length of rubber tubing interposed between. The application of an artery clamp was sufficient to seal the tubing while the syringe was withdrawn for refilling with atmospheric air. Porter and Rucker utilized a two-way needle connected by tubing to the mercury column and bulb of the sphygmomanometer; while Berg<sup>5</sup> modified their apparatus by interposing an air-cleansing chamber between the bulb and needle.

In accordance with the accepted custom, the joints were immobilized in extension for the first week. However, a careful study of the roentgenograms at that time persuaded us to remove such immobilization, to encourage active motion, and to further aid it by exercising in daily warm baths.

Case 1 was discharged in thirty-one days with no pain, extension to 180 degrees, and flexion to 70 degrees. Case 2 left the hospital in twenty-five days with but slight residual soreness, extension to 180 degrees, and flexion to 80 degrees.

The involved joints were roentgenographed at approximately weekly intervals. During the period of immobilization, these plates revealed mixed air and effusion in the suprapatellar pouch and anterior portion of the joint space proper, the effusion being especially pronounced in the posterior portion of the pouch. At no time during this period was either the popliteal bursa or the lateral aspects of the suprapatellar pouch ballooned by the injected air.

Roentgenograms taken during the period of active motion showed a prefemoral mound of organized effusion in the posterior portion of the

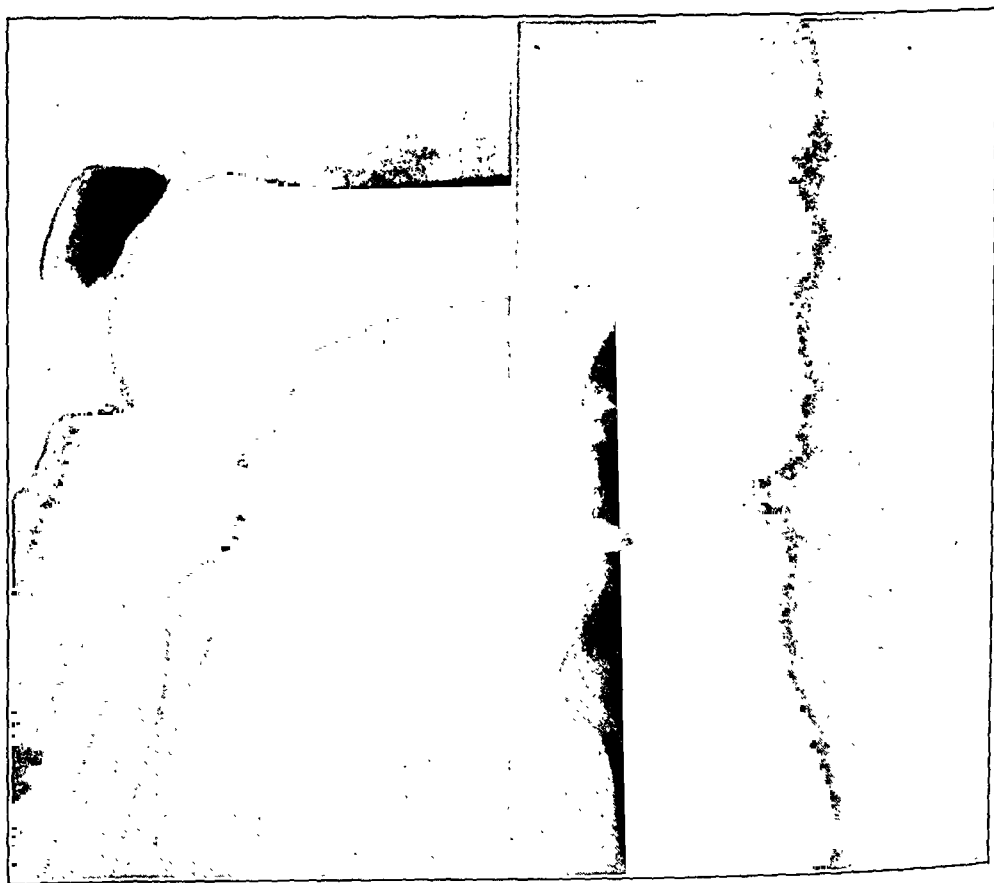


FIG. 4 .

Case 2. Roentgenogram at onset of the effusion. Mixed air and effusion are noted in the anterior joint space and suprapatellar pouch. The popliteal pouch is not visualized, nor are the lateral aspects of the suprapatellar pouch more than slightly outlined.

suprapatellar bursa and adhesions between it and the anterolateral aspects of the bursa. The popliteal bursa and lateral aspects of the suprapatellar pouch were ballooned by the injected air and, therefore, visualized during this period.

From a study of these plates, the course and sequelae of the synovitis were considered to be as follows:

1. The inflamed synovia produced an effusion which filled all of the joint spaces.

2. Some of this effusion escaped absorption, irrigation, and repeated aspiration, and became static in the dependent portions of the suprapatellar pouch and the joint proper during the period of immobilization. It soon became organized following invasion by fibroblasts and new blood vessels from the adjoining inflamed synovia.

3. Air insufflation separated this organizing effusion from apposing joint surfaces for the most part.

4. During the period of active motion fine adhesions in the joint space proper were rubbed free, while those in the pouch, being less affected by joint motion, were less molested and, therefore, allowed to become firmly organized.



FIG. 5

Case 2. Roentgenogram following a week of active motion. The margins of the suprapatellar pouch are indented in numerous places by the adhesions between it and the prefemoral mound of organized effusion. The popliteal bursa is clearly outlined by the injected air.



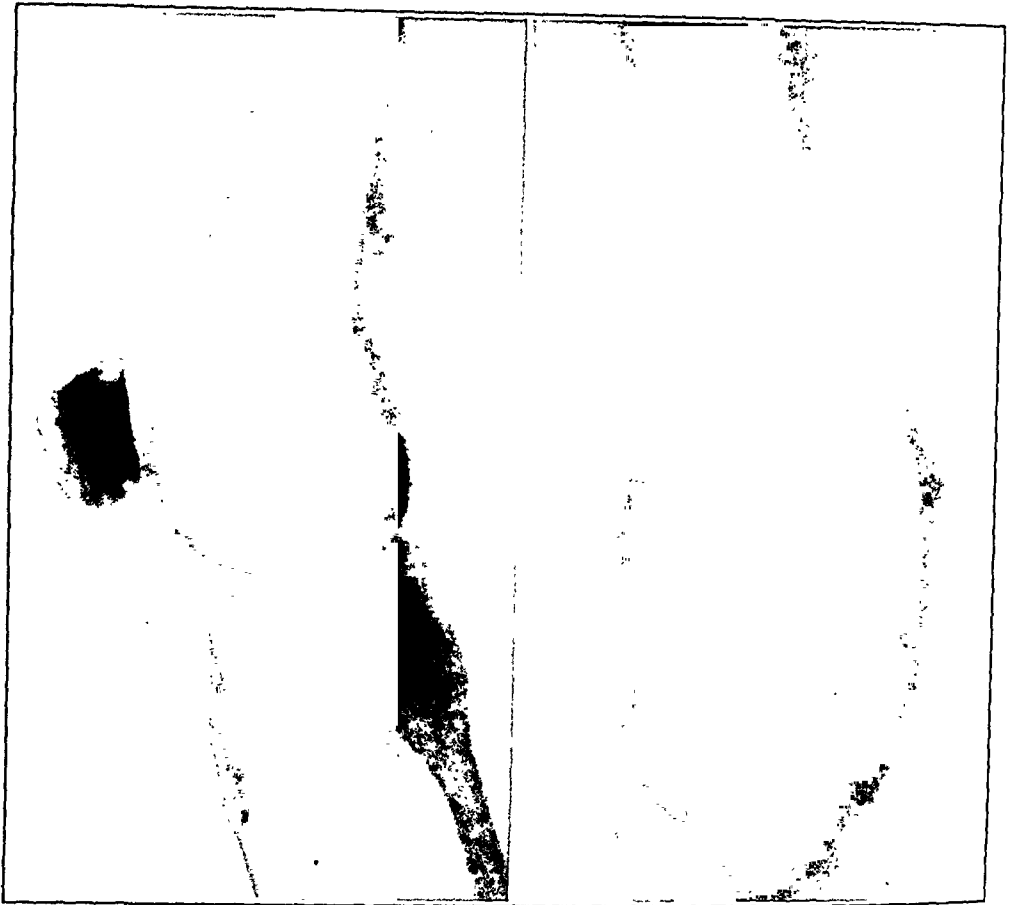


FIG. 6

Case 2. Roentgenogram after complete subsidence of the effusion and two weeks following the institution of active motion. The changes observed are essentially those shown in Fig. 5, except that the outlines of the suprapatellar pouch are more evenly outlined.

5. The limitation of flexion in these cases was due to interference with complete lengthening of the quadriceps tendon by the adhesions between it and the prefemoral mound of effusion.

In view of the trend of events mentioned, it appears advisable in the treatment of inflammatory effusions into the knee joint to forsake the time-honored procedure of immobilization, and, instead, to institute motion immediately in order to prevent potentially-organizing static effusions. Frequent aspiration and irrigation, to minimize the amount of effusion, and frequent air inflation, to separate the inflamed synovial surfaces, also appear to be rational aids in treatment.

#### CONCLUSIONS

1. In two cases of acute gonococcal synovitis of the knee, treated by a short period of immobilization and daily aspiration and air inflation, the patients recovered, with good functional results, in an average period of four weeks.

2. Roentgenograms taken of the air-filled joints revealed characteristic adhesions in the suprapatellar pouch, which account for the slight functional impairment encountered in these cases.

3. The sequelae of the effusion, as revealed by these roentgenograms, suggest that early motion and frequent aspiration and air inflation are valuable adjuncts in the intelligent treatment of this disease.

The author wishes to express his indebtedness to Dr. Arthur M. Wright, Director of the Third Surgical Division of Bellevue Hospital, without whose aid and inspiring encouragement this paper could not have been written.

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# SPINAL FUSION BY SIMPLIFIED TECHNIQUE

BY MYRON O. HENRY, M.D., AND EMIL S. GEIST, M.D.,  
MINNEAPOLIS, MINNESOTA

The following technique for fusion of the spine has been developed and used by the authors during the past nine years. It is a modification of the Hibbs method which can be carefully done in forty to fifty minutes by having a second operating team to remove the grafts. Multiple chip grafts are taken from the upper end of the tibia, which provides both cortical and cancellous bone; and the spinal bed is prepared by hand chisels without hammering. Complete and solid fusion is obtained by this method, and there is little or no danger of shock. Satisfactory results have been obtained in over seventy-five cases.

## TECHNIQUE OF OPERATION

The patient is prepared for operation in the usual manner. Shoulder rests (Fig. 2) are used to raise the chest slightly from the operating table, so as not to embarrass respiration during the operation. A mid-line incision, at least twelve inches in length, is made, centering over the area to be fused. The cut edges of the skin are iodized, as advocated by Naughton Dunn, before being walled off with towels.

With a sharp scalpel the fascia and the supraspinal ligaments are incised longitudinally, together with a portion of the interspinal ligaments, in order to freely expose the tips of the spinous processes. At least two segments above and below the affected area are fused, and therefore seven or eight spinous processes must be exposed. Next, with a broad raspatory (Fig. 1) the periosteum and muscles *en masse* are scraped off the spinous processes and laminae as far laterally as the articulations. Hemorrhage is slight and is controlled by packing on one side while the work continues on the other. The spinal muscles are then retracted laterally to expose the entire area to be fused. The

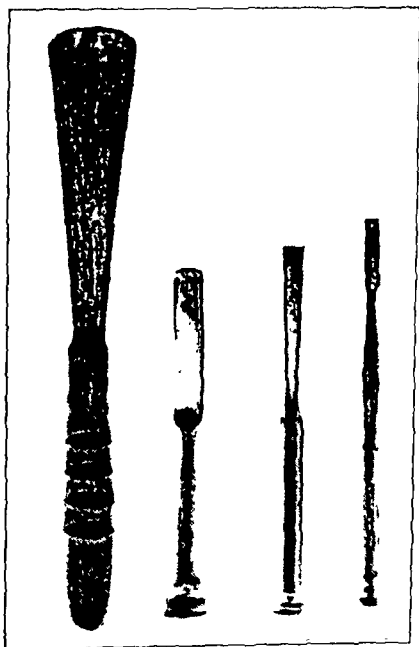


FIG 1

Raspatory, spinal hand gouge,  
and chisels.

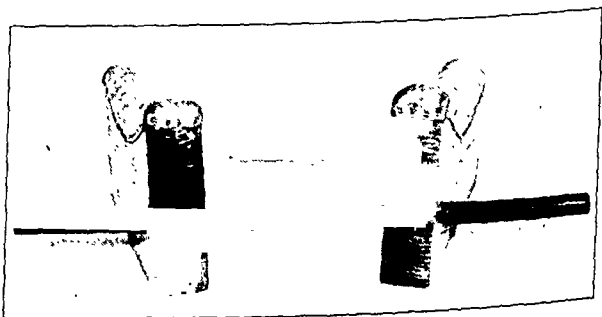


FIG. 2

Shoulder rests.

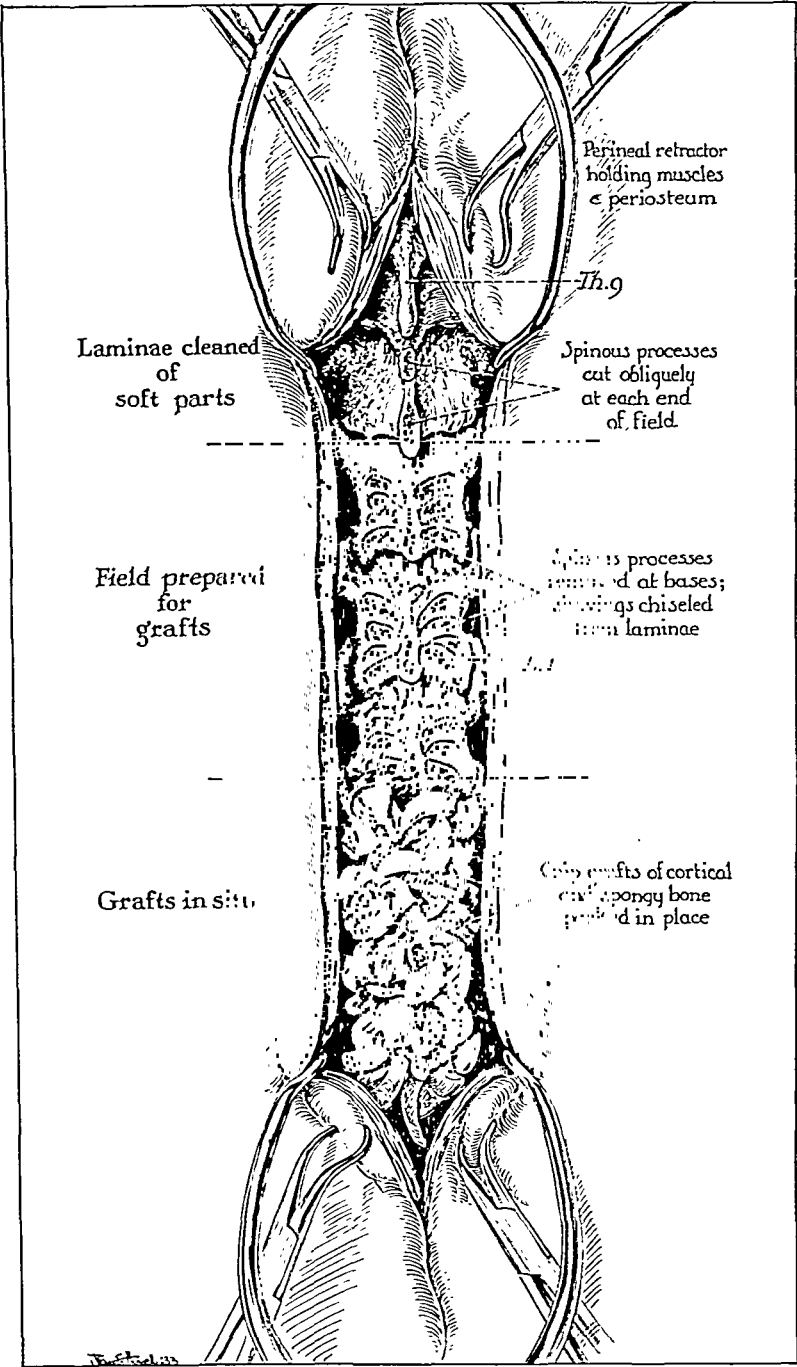


FIG. 3  
Operative technique.



FIG. 4  
Fusion for spondylolisthesis.



FIG. 5  
Fusion for chronic strain from unilateral  
sacralization.

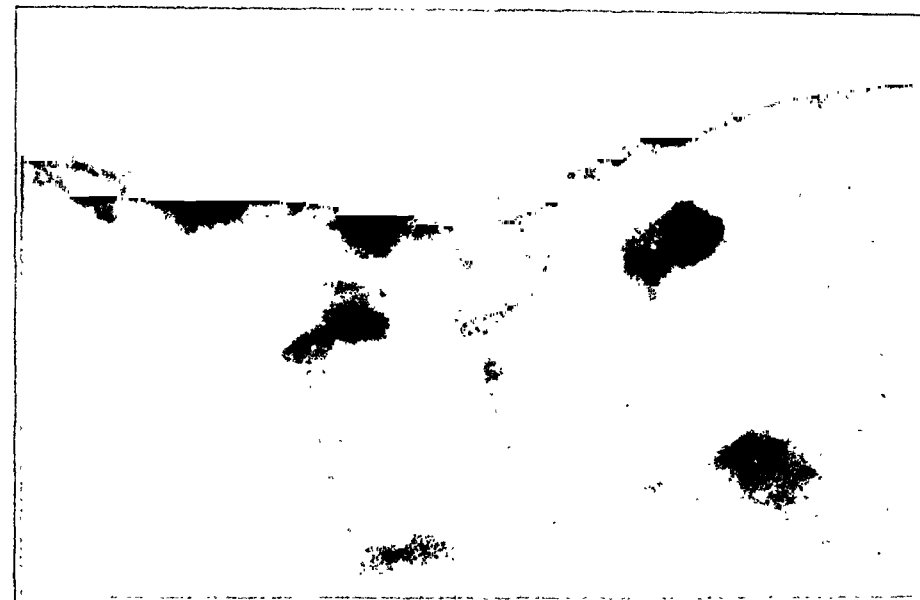


FIG. 6  
Fusion for tuberculous of the spine.

laminae are carefully cleaned of all soft parts from the bases of the spinous processes out to the articulations. Next, by using a hand chisel (Fig. 1) and utilizing the spines for leverage, small, thin shavings of bone are removed from the laminae until their exposed surfaces are entirely raw. The spinous processes with their intact interspinous ligaments are clipped off at their bases with a bone-cutting forceps. One spinous process at each end of the field is cut obliquely to avoid disfiguring bumps.

In the meantime, the subcutaneous surface of the tibia has been exposed by the second team. From it multiple chip grafts are removed with a chisel; none of these chips need be larger than the finger nail. During their collection, the chips are placed in a cup of normal saline, to

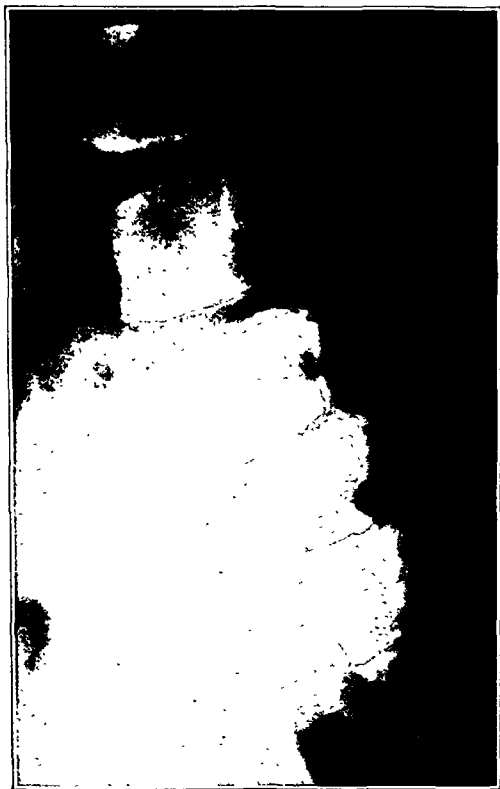


FIG. 7

Fusion for tuberculosis of the fifth lumbar with spina bifida occulta.

which a bloody sponge or two from the spinal area can be added to make the bath more nearly physiological. The cup of chips is kept warm in a small pan of warm sterile water. A large handful of these chips is needed, and the spinous processes, which have been removed from the upper field, may be cut up and utilized if time permits.

The chip grafts are quickly added to the spinal bed, distributed evenly over it, and pressed into contact with the raw laminae and each other, using the broad blade of the raspator. The periosteum, muscles, the remaining supraspinal ligament, and the dorsal fascia are sutured over the grafts with chromic catgut interrupted. The subcutaneous fat is closed with plain catgut continuous, and the skin is closed with dermal. In fat individuals, three or four stay sutures may be necessary. The incision is again iodized and mastisol is painted around the wound (but not into it), in order to seal the dressings to the skin and decrease the danger of wound contamination by perspiration.

The stitches are removed after twelve days, and a close-fitting, plaster-of-Paris jacket is applied on the Goldthwait irons. After ten weeks' recumbency, the patient is fitted with a brace of the Osgood type, having axillary crutches, which is usually worn for about three months.

## TUBERCULOUS BURSITIS WITHOUT ADJACENT JOINT INVOLVEMENT FOLLOWING TRAUMA \*

BY WILLIAM J. STEWART, M.D., COLUMBIA, MISSOURI

The occurrence of tuberculous disease of a bursa which does not involve the adjacent joint is rather rare. One such case was treated in our Clinic. Investigation of the literature of recent years, including standard orthopaedic textbooks, does not reveal a large number of such cases. Older articles<sup>1</sup> on the condition are found which contain no reference to x-ray findings of the adjacent bone or joint tissue and are consequently of little value. Cone<sup>2</sup> reports a case of subdeltoid tuberculous bursitis

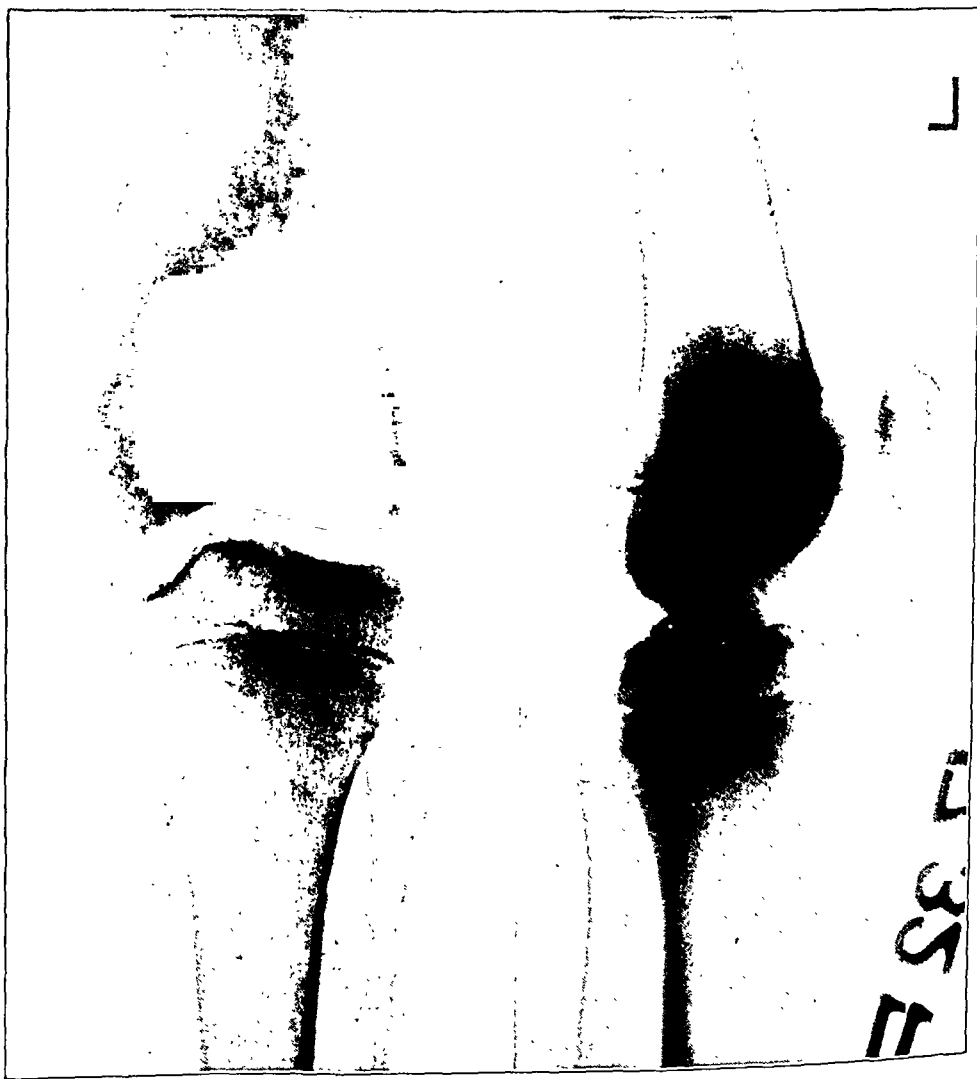


FIG. 1-A

Left knee, showing some elevation of the patella but no bone involvement.

\* From the Department of Orthopaedics, Crippled Children's Service, University of Missouri.

without joint involvement, Bérard and Dunet <sup>3</sup> another similar example. Ciapri <sup>4</sup> records tuberculous disease of the gluteal trochanteric bursa but gives no microscopic pathology. Torraca <sup>5</sup> reports the condition found in the subtricipital bursa at the elbow but mentions no x-ray findings or its possible connection with the elbow joint. A check of the standard orthopaedic texts in English reveals only one mention <sup>6</sup> of the condition.

The following is a case report from this Service:

An eleven-year-old, white male presented himself for examination, complaining of swelling in the left knee. Five months before, he had been hit by a baseball on this knee. There was immediate swelling of the knee with pain, lasting about one week. The first treatment by a physician consisted of massage with an iodine ointment which relieved the pain, but the swelling persisted. Six weeks after the injury, fluid was aspirated. It was bloody appearing and apparently had a few bits of flaky material in it. The patient was told that no organisms were found in the fluid. A plaster cast was applied which was left on for five weeks. After the removal of the cast, the knee was bandaged for two more weeks and then baking and massage treatments were instituted.

Physical examination in this Clinic five months after the injury was not remarkable except for the knee, which showed one-half inch greater circumference at the patella, a



FIG. 1-B  
Right knee, normal.



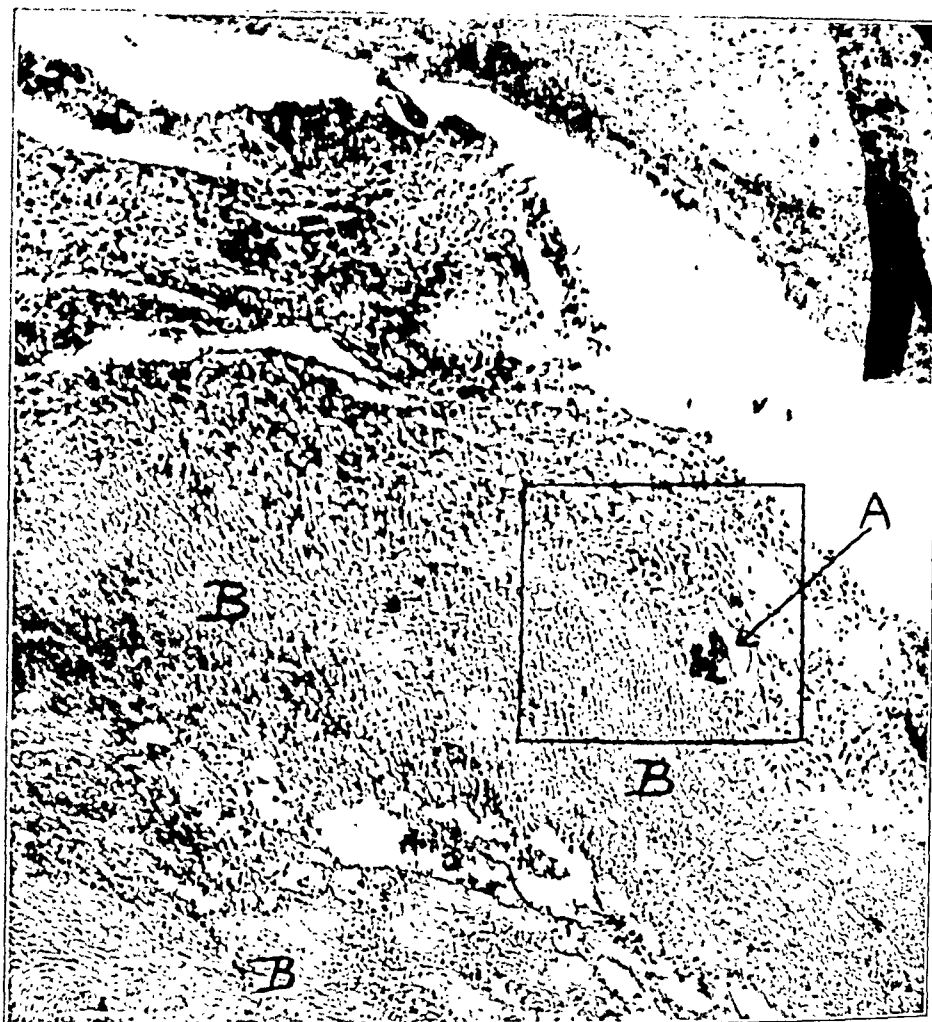


FIG. 2

Low-power photomicrograph, showing giant cell, *A*; with surrounding lymphocytic infiltration, *C*; and caseation necrosis, *B*. Area in square is shown in Fig. 3.

considerable amount of fluid in the suprapatellar bursa with some thickening about the joint. There were two painful nodular areas where the needle had been inserted previously to aspirate fluid. The patella was freely movable and floated, and the range of motion of the knee joint was complete and painless. There was some increased local heat. For a few weeks before this examination the patient had been having baking of this joint for six hours a day. Roentgenographic examination of both knees was made, as well as a complete blood count, clotting time, and Wassermann, as follows:

Red blood cells.....	5,328,000
Hemoglobin.....	100 per cent.
White blood cells.....	10,240
Polymorphonuclears.....	60 per cent.
Eosinophils.....	1 per cent.
Small lymphocytes.....	39 per cent.
Coagulation time.....	3 minutes
Wassermann and Kahn tests, negative.	

An Ace bandage was applied and the patient discharged for three weeks. It was felt that the excessive treatment by the heat might have been responsible for some of the condition.

Roentgenograms (Figs. 1-A and 1-B) showed no bone involvement.



FIG. 3

High-power photomicrograph of square in Fig. 2, showing a few epithelioid cells, lymphocytic infiltration, and adjacent caseous necrosis.

The patient returned in three weeks with a moderate amount of fluid still present and exploration of the bursa was done. A median parapatellar incision exposed the bursa. About fifty to sixty cubic centimeters of serosanguineous fluid with numerous chunks of fibrin were removed. Culture and guinea-pig inoculation from the fluid were done. The bursa was found to be very extensive, particularly toward the medial side. There was no communication with the knee joint and at the time of operation it was felt that the condition was simply a traumatic bursitis, overtreated. Accordingly, after removal of several portions of the sac for microscopic examination, strong tincture of iodine was introduced into the bursa and the wound closed without drainage. A compression bandage was applied to the knee.

Microscopic examination of the tissue removed showed numerous giant cells surrounded by a large number of epithelioid cells, lymphocytic infiltration, and definite tubercle formation (Figs. 2, 3, and 4) with several areas of caseation necrosis. No organisms were cultured from the fluid and the guinea pig that was inoculated was unfortunately accidentally destroyed without examination.

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FIG. 4

High-power photomicrograph of another area, showing giant cell, A, with surrounding zone of epithelioid cells and lymphocytes, and area of caseation necrosis, B.

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# SUBCHONDRAL GRANULATION TISSUE IN TUBERCULOSIS OF THE KNEE JOINT\*†

BY ERNEST A. BRAV, M.D., ROCHESTER, MINNESOTA

*Fellow in Orthopaedic Surgery, The Mayo Foundation*

Knowledge of the pathological changes in tuberculosis of the knee joint has been advanced by the researches of numerous investigators during the past century. The disease was first described as a clinical entity by Wiseman in 1676, who applied to it the name of "tumor albus". Its etiology, however, remained obscure. Bell, of Edinburgh, in 1779, expressed the opinion generally accepted at that time, in stating that tumor albus might be due to trauma, scrofula, or rheumatic inflammation.

Bayle and Laennec, early in the nineteenth century, were the first to point the way toward the present conception of the disease. They attempted to convince a skeptical medical world that the gross lesions known as "tubercle" were the result of a constitutional disturbance which could cause localization of the disease at various places in the body, and that these localized processes were pathologically one and the same. Acceptance of this doctrine was gradual. For another fifty years the term "tubercle of bone" was used to refer to any nodular swelling, and most writers still distinguished between this condition and "scrofula".

Rokitansky, in 1844, first demonstrated pathologically the presence of localized tubercles in the synovial membrane and pointed out their similarity to lesions in the lungs. Köster, in 1869, showed that these lesions could exist in so called scrofulous joints with no gross evidence to warrant the diagnosis of tuberculosis.

Following the discovery of the bacillus of tuberculosis by Koch in 1882, the classic description of tuberculosis of joints, both gross and microscopic, was presented by König in 1884, followed by more detailed studies in 1896 and 1906. Basing his observations on a large series of specimens obtained at necropsy, König portrayed accurately the various pathological forms of the disease and expressed pathogenetic theories which have undergone little alteration to the present day. Krause, in 1899, dealt at length with the pathological changes of the disease, and more recently they have been described by Nichols, Ely, Stiles, and Fraser, and several others whose views will be presented briefly.

According to Keith, Toynbee was the first to describe a "subarticular plexus" which formed below the cartilage in cases of inflammation of joints, uniting at times with the "superficial nucleated vascular membrane" in the substance of the cartilage, thus replacing it by fibrovascular

\* Thesis submitted to the Faculty of the Graduate School of the University of Minnesota in partial fulfillment of the requirements for the degree of Master of Science in Orthopaedic Surgery, October, 1932.

† Submitted for publication January 4, 1933.



Cunningham, Sabin, and others, has thrown an entirely new light on the subject.

It is fairly well established that tuberculosis of the knee may occur primarily either in bone or synovial membrane. If the bone is first involved, the disease spreads from the epiphysis to the articular cartilage, eroding and perforating it, or it advances to the synovial membrane at its point of reflection from the bone. In either case, the original lesion is the primary tubercle which either becomes encysted and localized or infiltrates the tissue, depending on the virulence of the infection and the amount of individual resistance of the host. In the process of invasion, conglomerate tubercles and diffuse granulation tissue are produced. The bony trabeculae are eroded and the marrow is replaced. Uniform atrophy of the surrounding bone and a tendency to wall off the infection by formation of fibrous tissue occur. If small portions of necrotic bone are not absorbed, minute sequestra or "bone sand" result. If the nutrition of a rather large portion of bone is cut off by a tuberculous embolus or by tuberculous granulations, a large V-shaped sequestrum forms with its base usually on the surface of the joint. If the granulations undergo caseation, gross abscesses may form in the bone or in the synovial membrane.

When the synovial tissues become involved, whether primarily or secondarily to disease in the bone, certain additional changes occur. The original miliary tubercle advances through the synovial substance, although the progress may be slow, as is often the case in tuberculous lesions. In addition, a tuberculous pannus grows across the articular surface from the synovial reflection, eroding the cartilage from above. There is invasion of the bone at the margin of the joint, and this may progress from the line of attachment of synovial membrane to the deeper bony tissue. Finally, at the synovial margin, a thin layer of granulation tissue is formed, which progresses between the cartilage and the bone toward the center of the joint, eroding the two adjacent structures as it advances. Little has been written concerning the nature of this subchondral granulation tissue. It is my purpose in this paper to deal solely with the structure of these subchondral granulations, and to emphasize their relationship to the concurrent gross and microscopic changes taking place in other portions of the tuberculous knee joint.

#### MATERIAL STUDIED

A study was made of 102 tuberculous knee joints, obtained by resection or after amputation. All specimens included the largest portion of the lower end of the femur and the entire upper end of the tibia and were complete. In more than half of the cases the patella was also intact. In ninety-one of these cases, microscopic sections were made through various portions of the articular surface. When a pannus was present, an effort was made to cut the section through the point of attachment so that marginal pannus, cartilage, subchondral granulation tissue, and bone

would be present in the section. The tissue was decalcified with nitric acid, embedded in celloidin, and sections were cut and stained with methylene blue and eosin.

#### MICROSCOPIC CHARACTERISTICS OF SUBCHONDRAL GRANULATION TISSUE IN THE MATERIAL STUDIED

In this series of ninety-one microscopic specimens the subchondral granulation tissue was found to be distinctly tuberculous in eleven (12.1



FIG. 1

Section through the margin of the femoral condyle. Symptoms existed for eight months. A tuberculous pannus is growing from the margin toward the center of the joint. Subchondral granulations of non-specific type are approaching the pressure area from the line of synovial reflection. The cartilage has been invaded by the subchondral granulations, but in this case the pannus has produced no erosion of cartilage ( $\times 7$ ).

per cent.). In fifty-three cases (58.2 per cent.) definite subchondral granulations were not demonstrable because of complete cartilaginous destruction, or because of the presence of a bony tuberculous focus beneath the cartilage. In the latter cases it was impossible to determine whether the tuberculous tissue beneath the cartilage was the result of the advance of the bone lesion toward the surface of the joint or of the ingrowth of subchondral granulations from the margin of the joint. In twenty-seven cases (29.7 per cent.) the subchondral granulations gave no conclusive evidence of tuberculosis, although in several

of them the presence of numerous epithelioid cells, with an occasional foreign-body giant cell, was highly suggestive of such a condition.

Although theoretically the earliest lesions in tuberculosis of the knee joint may be limited either to the bone or to the synovial membrane, in every one of the specimens studied there was evidence of the disease in

both of these structures. In several specimens derived from patients who had had symptoms of only two or three months' duration this finding was constant. In them the bony structure was eroded at the margins by tuberculous tissue arising at the point of synovial attachment, and a layer of granulation tissue was seen to be progressing beneath the cartilage toward the center of the joint (Fig. 1). In one section a primary bony focus had spread to the margins of the joint, followed by formation of subchondral granulations as in the primary synovial type.

This observation is of practical significance, because it demonstrates the futility of conservative surgical procedures in tuberculosis of the knee joint. By the time the symptoms are sufficiently evident to cause the patient to seek treatment, a synovial lesion already will have invaded the bony structure. At operation the disease may appear to be distinctly limited to the synovial membrane, in which case partial or total synovectomy may seem to be indicated. In practically every case, however, there is hidden below the apparently intact articular surfaces beginning marginal tuberculous erosion and subchondral infiltration, which make entirely useless any surgical procedure short of resection of the surfaces of the joint.

In no instance was tuberculous tissue, the result of a primary bony focus, and present beneath the articular cartilage, called "tuberculous subchondral granulation tissue". Only definite uninterrupted tuberculous tissue arising from a marginal lesion and advancing beneath the cartilage to the center of the joint with no contiguous bony lesion was placed in this category.

In twenty-seven of the cases, ordinary granulation tissue was found to exist beneath the cartilage. This consisted of a layer of varying thickness, comprising fibroblasts, round cells, young capillaries, and in some instances foreign-body giant cells. In each case definite tuberculosis was present in the synovial membrane at its point of attachment to the bone, but no characteristic tuberculous lesions were found in the subchondral tissue. In some cases, however, tuberculous granulations had begun to erode the marginal bone adjacent to the diseased synovial membrane.

Above and below the layer of subchondral granulation tissue there existed evidence of destruction of cartilage and of bone, respectively. At certain points the granulations were seen to enter the substance of the cartilage and on the other side to extend somewhat more deeply into the bony structure. The basal cartilage cells appeared swollen and degenerated, and in some cases there was beginning fibrillation. Giant cells were often present in large numbers at the base of the cartilage, evidently taking active part in the process of destruction. In several specimens the subchondral penetration was seen to unite, in the body of the cartilage, with the invading tuberculous pannus from above. In these sections the twofold process of cartilaginous thinning and destruc-





FIG. 2

Section through tibial tuberosity, showing tuberculous subchondral granulations advancing in unbroken line from a synovial focus to the center of the joint. The cartilage is dead and has been partially separated from the bone. At the pressure area the subchondral granulation tissue encircles a small sequestrum and then continues onward beneath the cartilage ( $\times 4$ ).

tion was readily demonstrated. The bony tissue was similarly eroded in many instances, the trabeculae appearing atrophic, fragmented, and surrounded by numerous foreign-body giant cells.

Whereas in most instances the width of the layer of subchondral granulations was practically constant from the margin of the joint to the center, in some of them a difference was noted. In nine of the twenty-seven cases mentioned (33.3 per cent.), the granulations were more luxuriant at the margin, thinning out as they advanced to the area of pressure. In three cases (11.1 per cent.), there was distinctly more evidence of subchondral granulation tissue at the central portions than at the periphery, whereas in fifteen cases (55.6 per cent.), the layer was uniform in width.

If, as Phemister has suggested, subchondral granulation tissue is a foreign-body tissue reaction to destroyed cartilage, it is reasonable to believe that this tissue would be found only in the regions where there is evidence of such a process. Of this group of twenty-seven specimens, the sections of which revealed non specific subchondral granulations, in six cartilaginous destruction was greater at the pressure areas; fourteen specimens presented greater marginal destruction; and in seven the destruction was uniform in the pressure areas and at the margin. Of the six specimens in which central destruction was greater, in five there were, microscopically, equal amounts of subchondral granulations on both regions of pressure and at the margins, whereas in one there were more granulations at the center of the joint. In the fourteen specimens with greater marginal destruction there were only marginal or more extensive marginal granulations in eight cases, more abundant central granulations in two cases, and a uniform amount of granulation in four cases. Of the seven specimens with uniform cartilaginous destruction, there were

evenly distributed subchondral granulations in six, and in one the tissue was found to occur more extensively at the periphery.

Since there seems to be no consistent relationship between the site of cartilaginous destruction and the region of maximum growth of subchondral granulation tissue, it does not appear probable that the latter is merely a reaction to contiguous foreign material. In specimens with only marginal cartilaginous disease, there were in some cases subchondral granulations beneath the intact central portion. In those with marked central destruction and practically intact marginal cartilage, the subchondral granulations were always seen beneath both portions. In no case were granulations limited to the central region of destruction.

Several of the sections which have been classed as non-specific subchondral granulation tissue had characteristics resembling tuberculosis. In them were seen collections of epithelioid cells and lymphocytes which lacked only the typical configuration for the diagnosis. Since these collections were also at times seen in sections which elsewhere displayed tubercles, it is possible that they represent an early type of lesion or a reaction to a weakened tuberculous infection. Foreign-body giant cells were noted in fourteen (51.8 per cent.) of the specimens of granulation tissue classified as non-tuberculous. These alone were not considered suggestive of tuberculosis.

When a diagnosis was made of tuberculosis in the subchondral granulation tissue, there were always present the characteristic structure and configuration, and in all cases the tissue was seen to be extending in unbroken line from a synovial focus to the center of the joint (Fig. 2). Collections of epithelioid cells and lymphocytes were considered essential to the diagnosis, with or without the presence of giant cells. In all



FIG. 3

Section through the center of the joint showing tuberculous nodules in the subchondral granulation tissue ( $\times 65$ ).

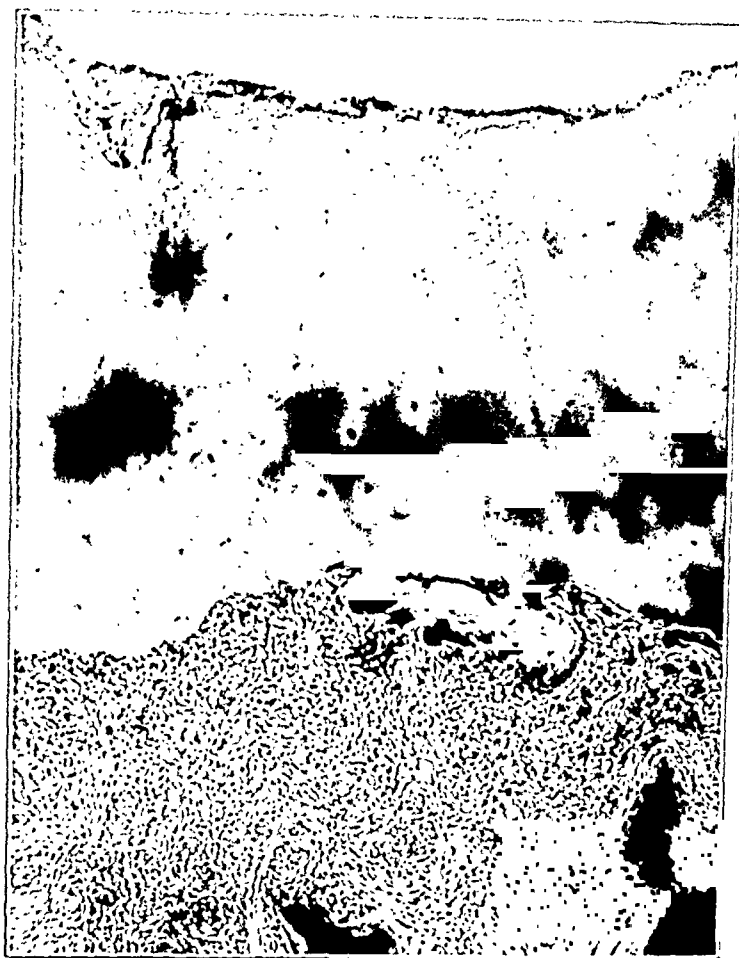


FIG. 4

Section through the pressure area in a specimen in which greatest cartilaginous destruction is at this point. The cartilage has been eroded by the opposed pressure. The cartilage cells are enlarged and degenerated and there is beginning fibrillation. Subchondral granulations of non-specific type are present below the central cartilage, causing thinning and loss of nutrition ( $\times 65$ ).

the cartilage, to surround the region of sequestration and then to proceed beneath the cartilage again (Fig. 2). In only one of the seven cases was there evidence of a bony tuberculous focus. In two cases the sequestra were entirely denuded of cartilage. In the remaining five, dead cartilage covered the necrotic bone, and in none of these were subchondral granulations present beneath the cartilage of the sequestrum although they did exist beneath adjacent cartilage. Sequestra were noted at the pressure area in six cases and at the margin in one case.

The subchondral granulation tissue, whether or not definitely tuberculous, seemed to bear no relationship to the marginal pannus formation. In some specimens in which the process was not advanced there was apparently granulation tissue extending below the cartilage to the same extent as the pannus existed above it. However, in most cases the granulations were present below the center of the cartilage over which the pannus did not exist, or they were seen only at the very margins with a well-

sections there was a nodular form of tuberculosis (Fig. 3). In no case was caseation present in the subchondral tissue, although in the same sections it was sometimes noted in the tuberculous pannus.

Just as in the case of the non-tuberculous tissue, the regions where the subchondral granulations were most luxuriant did not correspond to the situation of greatest cartilaginous destruction. In seven cases sequestra were present in the sections. These were never noted where the subchondral tissue was not definitely tuberculous. The granulations in these cases were seen to dip down below

developed pannus on the surface of the cartilage. In the majority of the sections one could demonstrate a more extensive encroachment of the center of the joint by subchondral granulations than by pannus.

#### COMMENT

Subchondral granulation tissue evidently takes an active part in the progress of tuberculosis of the knee joint. Whether or not this tissue can be shown to contain definite tubercles, it is responsible for many of the pathological changes in cartilage and in bone. Marginal erosion of the bone in cases which appear grossly to have only involvement of the synovial membrane is one of its most important accompaniments. Destruction of cortical bone with little if any diminution of the joint space, one of the earliest roentgenographic signs, is the result of the invasion of subchondral granulation tissue.

Destruction of cartilage at the center of the joint is due largely to the presence of subchondral granulations. Cartilage, in tuberculosis of the knee joint, is destroyed by (1) the marginal pannus, (2) tuberculous toxins, (3) pressure of opposed articular surfaces, and (4) subchondral granulation tissue. König was the first to observe that usually the cartilage is preserved at the areas of contact and pressure and destroyed at the periphery. Phemister pointed out that the superficial pannus is usually rubbed off at the center of the joint, due to opposing pressure. He stated that in tuberculous joints, unlike pyogenic joints, the central cartilage is not often eroded by the effects of pressure, because its resistance is not greatly impaired by the action of the tuberculous toxins which are lacking in proteolytic ferments.

When subchondral granulation tissue is present beneath the center of the joint, however, the picture is somewhat altered. The central cartilage is attacked from below, its nutrition is impaired, and it becomes less resistant to the effects of opposing pressure. Thus, of the thirty-eight specimens showing definite subchondral granulations, ten gave evidence of greater destruction at the center of the joint, and every one of these presented microscopically a central growth of subchondral granulation tissue (Fig. 4), four being definitely tuberculous. Of the sixteen specimens with greater marginal cartilaginous destruction, only seven (43.8 per cent.) had subchondral granulations beneath the central cartilage and none of these was tuberculous. Therefore, it appears that the tuberculous infection incites a response of granulation tissue beneath the cartilage, and that this is one of the most important factors in determining the site of greatest cartilaginous destruction. Why in some cases there should be more central advance of this tissue, with resultant destruction in pressure areas, is as yet unexplained. Weight-bearing seems to be of only minor importance. About half of the specimens with greater central destruction were derived from patients who had given histories of having walked on the leg most of the time prior to operation. The histories of

the others indicated that there had been some treatment at one time designed to place the joint at rest.

Duration of disease likewise appears to bear little relationship to the growth of subchondral granulation tissue. The nine specimens with marginal destruction and no central subchondral granulations were from patients who had had evidence of disease over a period averaging four and four-tenths years, whereas the seven specimens which exhibited this tissue at the center of the joint were from patients who had had evidence of disease for a period averaging only three and seven-tenths years.

From a practical point of view, the question has been raised as to whether traction is indicated in the non-operative treatment of tuberculosis of the knee joint. It has been shown that the superficial erosion of cartilage at the center of the joint, by formation of pannus, is prevented or at least delayed until the late stage of the disease by the pressure of the opposed surfaces. Judging from this observation alone, traction would appear to be contra-indicated. However, if there is a central growth of subchondral granulation tissue in the joints and traction has not been applied, there will result in most cases erosion of the central cartilage from the effect of the opposing pressure. Obviously there can be no uncompromising rule established for suitable treatment in all cases.

Severity of the tuberculous infection and the amount of individual resistance may be factors in determination of the amount of subchondral granulation tissue formed and consequently in determination of the site of greatest cartilaginous destruction. In this series there was no clinical evidence of such factors having been causes of the changes mentioned. It is possible, as Phemister has suggested, that in severe tuberculous infections the toxins produced within the joint are capable of reducing the resistance of the central cartilage to the opposing pressure area, as in pyogenic joints.

Subchondral granulation tissue seems to be of importance in the formation of bony sequestra at the articular surfaces. König believed that sequestra were due to the blocking of an epiphyseal vessel by tuberculous tissue, thereby causing necrosis of bone in a V-shaped area with the base on the articular surface. Phemister wrote also of "secondary sequestra" which, according to the belief he expressed, are formed by invasion of the central bone by tuberculous tissue penetrating the cartilage from the surface of the joint. In this series of thirty-eight specimens, the presence of sequestra was demonstrated in seven. In one case there was evidence of a bony focus which might have been the cause of the region of necrosis. None gave evidence of penetration of the central cartilage as an etiological factor of secondary infection. In six cases the subchondral granulation tissue was seen completely to surround the sequestra except on the cartilaginous surface. In these, the granulations appeared to play a definite part in the formation of sequestra, some unexplained change in the reaction of these portions of the bone causing the granulations to

proceed around rather than through them. The observation that in each of the six cases the sequestrum occurred at the pressure area may be of more than incidental importance in the mechanism of their formation.

#### SUMMARY

Microscopic sections through the articular surfaces of ninety-one tuberculous knee joints were studied. The complete joint was available in each instance. In forty-one and seven-tenths per cent. of the cases subchondral granulation tissue, arising from the margins of the joint, was seen to exist between the cartilage and the bone. Of the specimens in which subchondral granulations were present, there was definite evidence of tuberculosis beneath the margin and center of the cartilage in twenty-nine per cent. Several others were extremely suggestive of tuberculosis but in them definite diagnosis could not be made. Subchondral granulation is probably a tissue reaction to an infectious process, rather than to foreign material in the form of degenerated cartilage. Whether or not it presents the actual cellular characteristics of tuberculosis, it must be considered potentially tuberculous. Subchondral granulation tissue in tuberculosis of the knee joint plays an active part in erosion of bone, demarcation of sequestra, and destruction of cartilage.

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## FRACTURES OF TIBIA AND FIBULA

### KIRSCHNER WIRE METHOD USING A NEW FRAME AND NEW SUPPORT FOR WIRES \*

BY C. F. EIKENBARY, M.D., F.A.C.S., AND JOHN F. LECOCQ, M.D.,  
SEATTLE, WASHINGTON

A perusal of the records of the Industrial Insurance Department of almost any state must leave one with the thought that the results of treatment of fractures of both bones of the leg are far from satisfactory. The examination of the roentgenograms in most general hospitals would lead one to the same conclusion. Quite a percentage of the cases show a moderate or even a marked malalignment, resulting in improper weight-bearing. A slight malalignment is quite apt to produce a marked disability. In no other fracture is the question of alignment of greater importance. Many of the cases that are properly aligned will show too little contact, or even an overriding. While a partial contact may eventually give a good functional result, it is too often true that a fairly high degree of permanent partial disability will result; and always the period of convalescence is too prolonged.

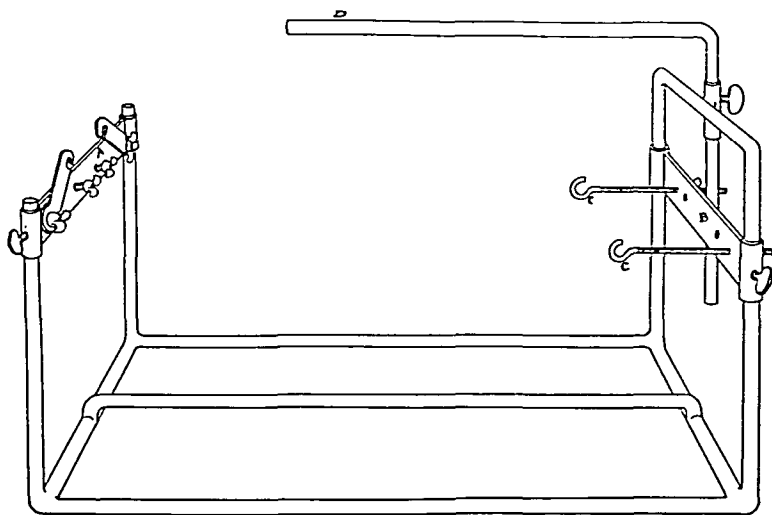


FIG. 1

Traction frame. The cross bars *A* and *B* are adjustable up and down. The horse-shoe metal supports, to which the transfixing piano wires are secured, are firmly anchored to the bar at *A*. *C* and *C'* are the traction hooks, operated by two thumb screws (Fig. 7). By tightening or loosening one or the other of the thumb screws, a lateral shift of the lower fragment may be obtained. *D* is an overhead piece, detachable, for supporting the leg (Figs. 7 and 8).

\* Presented at the Annual Meeting of the American Orthopaedic Association, Washington, D. C., May 11, 1933.



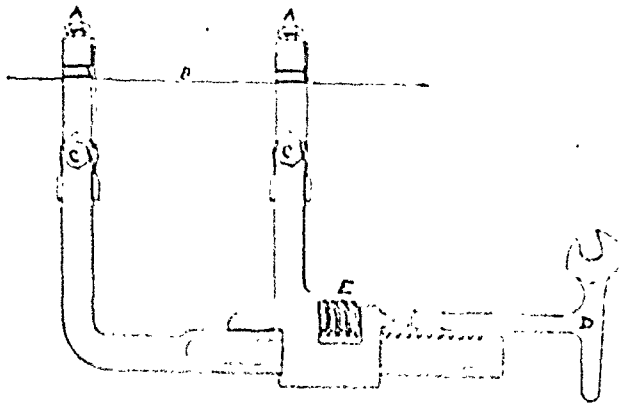


FIG. 2

New type of cross support for Kirschner wires. *A* and *A* tightening nuts for securely clamping wire *B*. *C* and *C* nuts for clamping the terminal bars into the main body of the frame. By means of the adjustment screw *E*, almost any width may be secured. *D* is the tightening wrench.

In reviewing the roentgenograms of the Industrial Insurance Department, or of most any general hospital, we are rather forcibly impressed with the thought that the failure to ultimately achieve perfect functional results is not because of failure to secure good reduction. The roentgenograms generally show that very excellent reduction was obtained, but later roentgenograms all too frequently show that the good reduction has changed to a displace-

ment, either moderate or severe. The question immediately arises as to why, under treatment, this displacement should occur. And can it be prevented?

Probably the most common method of treatment in this type of fracture, certainly the most common method in the hands of the general

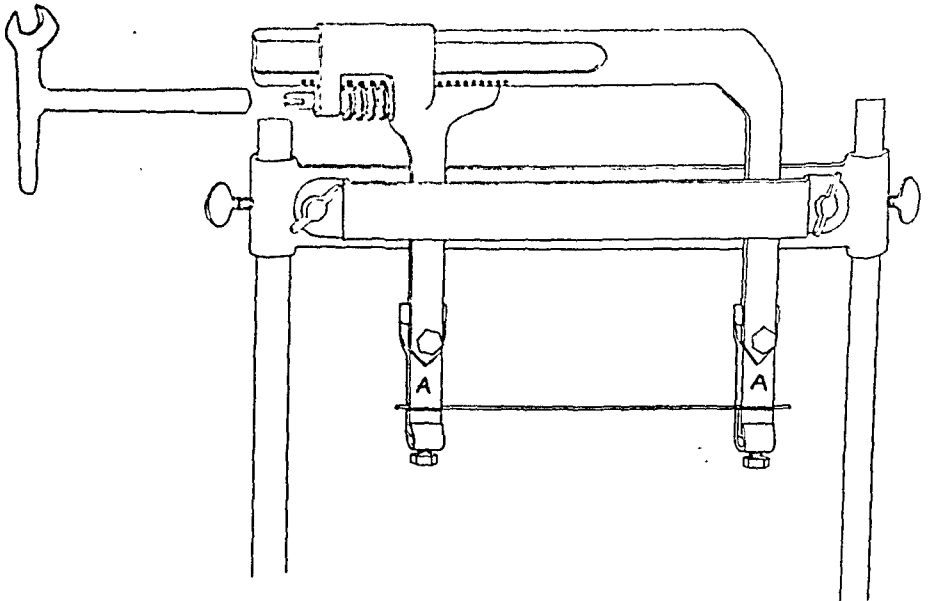


FIG. 3

End view of frame, showing the upper U-shaped support in position and firmly clamped. After reduction, only the terminal portions *A* and *A* remain in the plaster.

practitioner, is the application of a plaster support. Mechanically, a plaster support is anything but ideal. The bone is a very unyielding substance, surrounded by a very soft, yielding, contracting muscular cushion. Regardless of how snugly the plaster is applied, and regardless of the position of the foot or knee, the soft, yielding muscular cushion is still

present. This being true, there is every reason for the slightest contraction of the muscles to produce displacement. If all fractures were deeply serrated, and we could always so reduce them that the serrations were perfectly fitted into each other, then we might be reasonably certain that most any type of support would suffice. But such is far from the case. Very few fractures are completely transverse, and even if they are, we seldom reduce them so perfectly that the bony serrations can maintain the reduction.

Open operation with plating or some other form of internal fixation will, of course, maintain the position. The advantages and disadvantages of this method of treatment have been

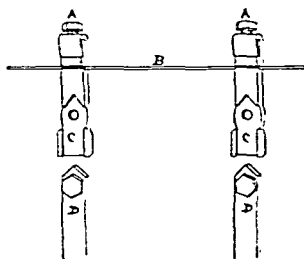


FIG. 4

Showing the terminal bars *C* and *C* disconnected from the major portion *D* and *D*. Only the terminal bars are left in the plaster.

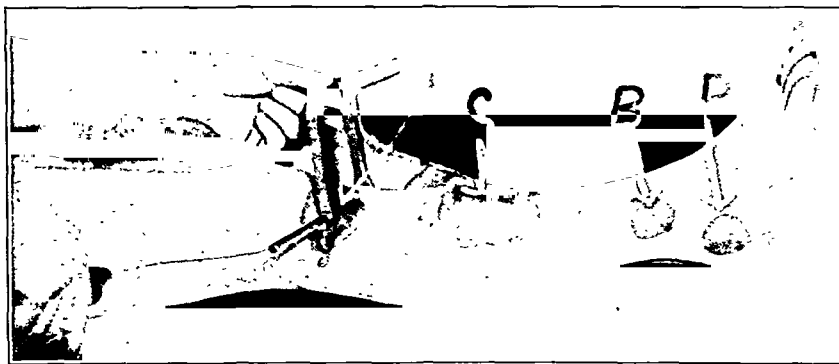


FIG. 5

Sites for injecting the two per cent. novocain. *A*, site for the upper wire. *B*, the lower wire. *C*, the fracture. *D*, the os calcis. We no longer use the os calcis for traction purposes.

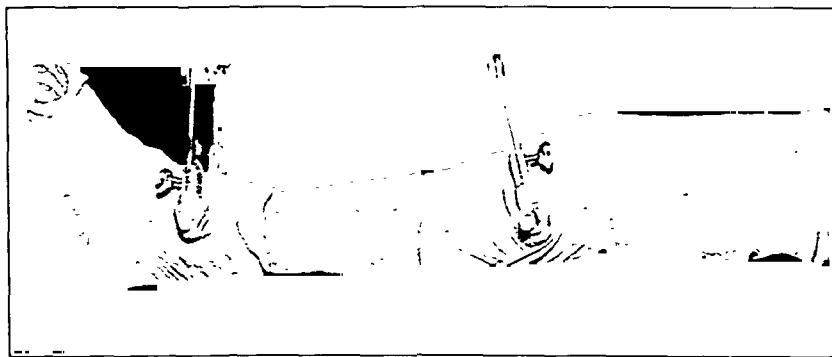


FIG. 6

The two plasters have now been applied, and the metal horse-shoe supports that anchor the wires have been firmly imbedded in the plaster.

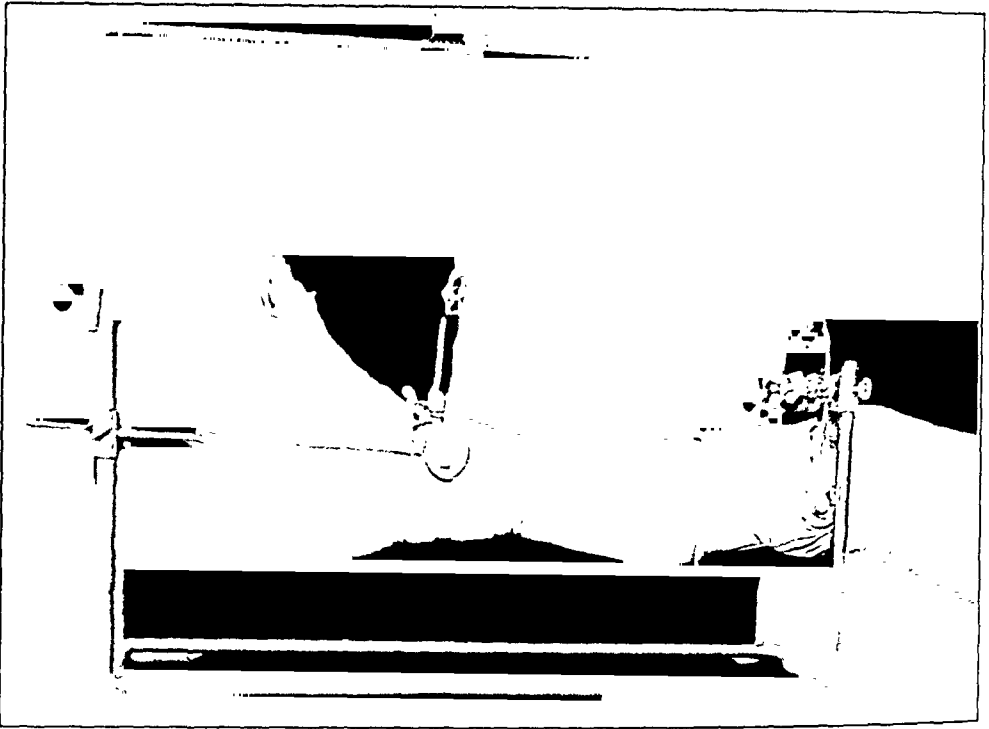


FIG. 7

The leg is now placed in the traction frame, and reduction accomplished by means of traction on the wires that are fastened to the thumb screws.

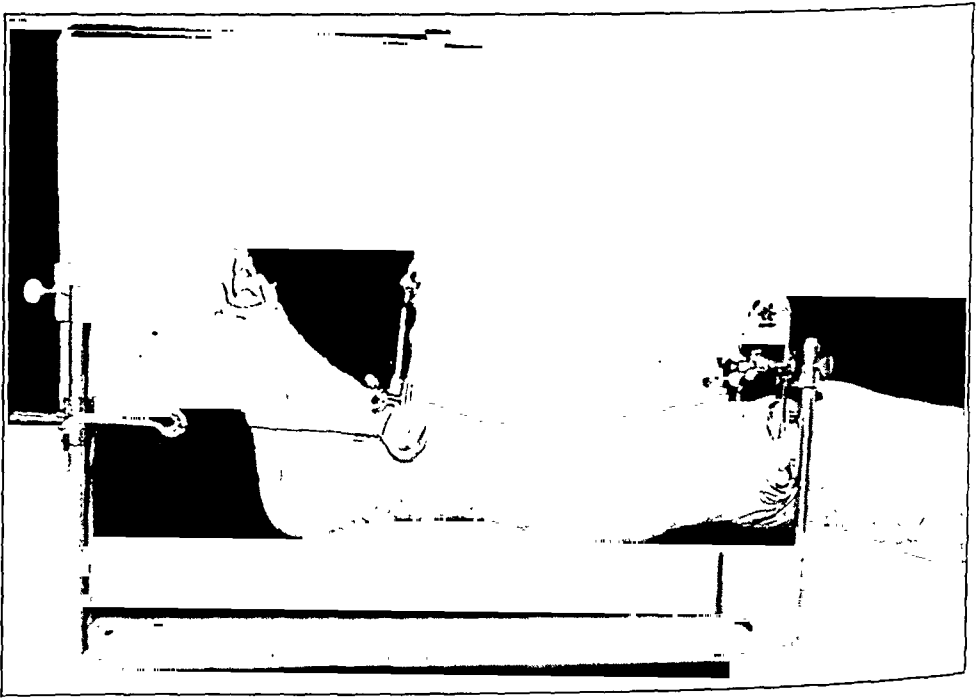


FIG. 8

The fracture is now reduced and the connecting plaster applied.

The fractured tibia, the piano wires, the metal supports, and the plaster are now one, and move as one. Regardless of position displacement cannot occur.

discussed many times. There is nothing new to add. However, the innumerable cases of draining sinuses and of non-union should be sufficient to convince us that open operation is not a treatment to be

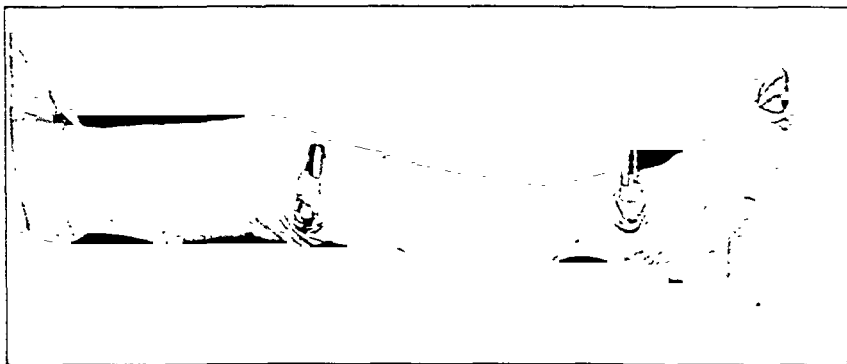


FIG. 9

The transverse portions of the metal supports have been removed. The plaster securely anchors the lateral supports for the piano wires. The patient now becomes ambulatory, using crutches.

routinely used. In the hands of most men it is a dangerous procedure. In practically all cases it is quite unnecessary.

To maintain reduction, it is necessary in most cases to use traction, either fixed or otherwise. Traction in bed, preferably by the skeletal method, will certainly suffice to insure proper length and alignment. Its only disadvantage is the necessity of keeping the patient in bed. Considering the cost of hospitalization, the necessity of long confinement in bed becomes quite a serious problem.

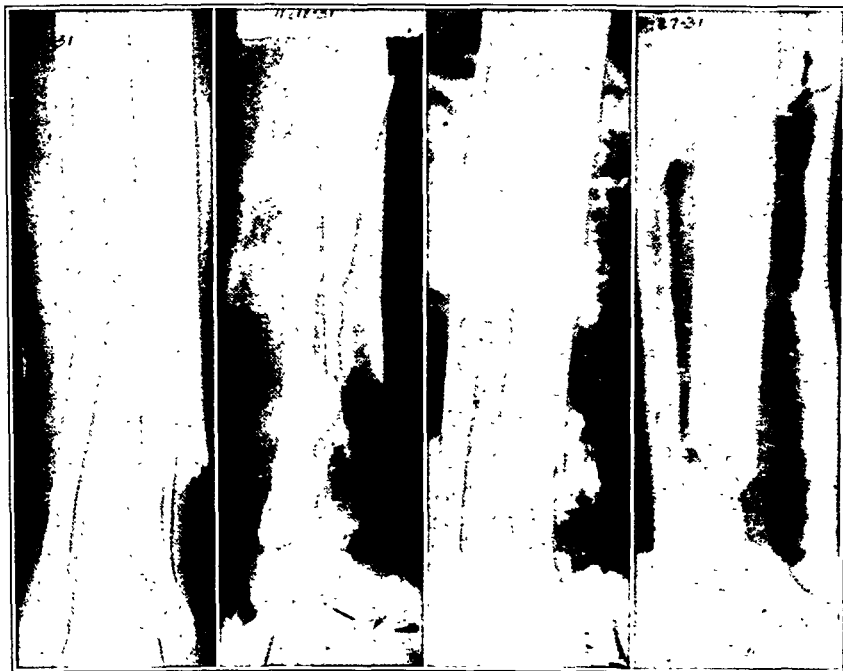


FIG. 10  
Case 1.

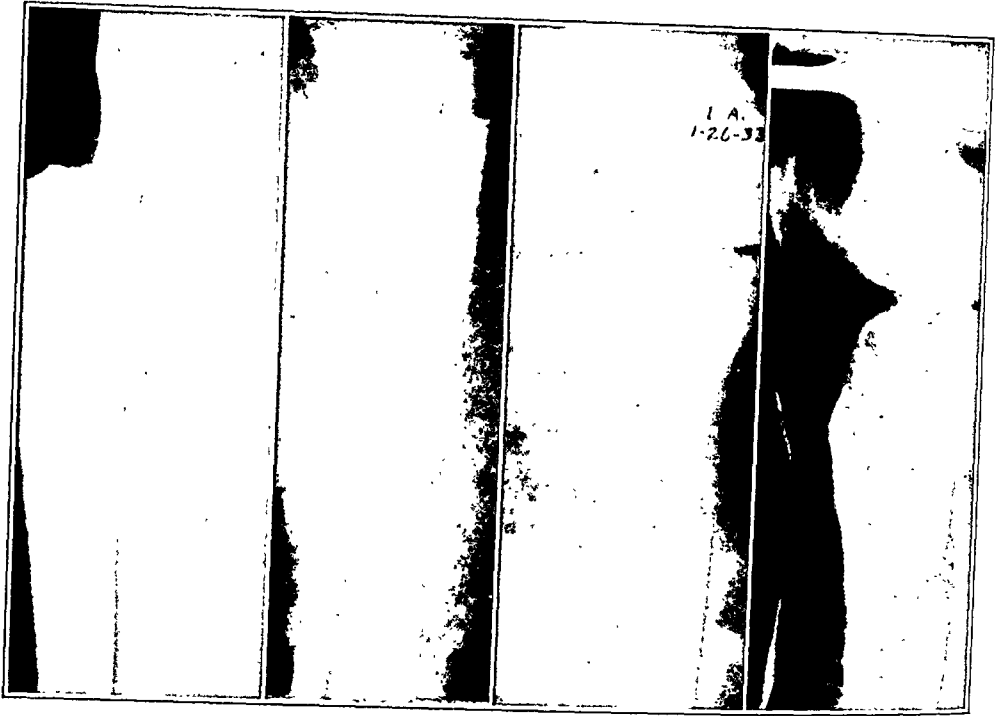


FIG. 11  
Case 2.

The ideal method is one whereby the fracture may be reduced, the traction maintained, the fracture so fixed that displacement cannot occur, and the patient allowed to be up and about. The use of Kirschner piano wires ideally answers all the above requirements. For several years we have used the following method and have had absolutely no reason to question its efficiency:

1. Local anaesthesia in the site of fracture as well as in both the upper and lower ends of the tibia (Fig. 5).

2. Transfixing both the upper and the lower ends of the tibia by the piano wires. The small wires are pointed as for drilling. No incision is necessary, the wires being drilled through the bone, the opening being just about the size of a hypodermic needle (Fig. 5).

3. Securing the wires to the metal cross support and then tightening the wires until they are quite rigid (Fig. 2). When tightened, a pull of fifty pounds will not produce an appreciable bend.

4. Application of a plaster support from the mid-thigh to a point just above the site of fracture, and another plaster support including the foot and going up to a point just below the site of fracture. These two plasters are firmly attached to the two U-shaped cross supports (Fig. 6).

The plaster having firmly set, the leg is placed in the traction frame (Fig. 1). The upper U-shaped cross support, holding the piano wire, is firmly clamped into the proximal portion of the frame (Fig. 7). Traction wires are now carried from the lower U-shaped support to the turn screws (Fig. 7), after which any necessary traction may be applied. By tightening and loosening either wire, a lateral shift can be obtained. The position of the fracture is now checked by x-ray. If satisfactory, the distal

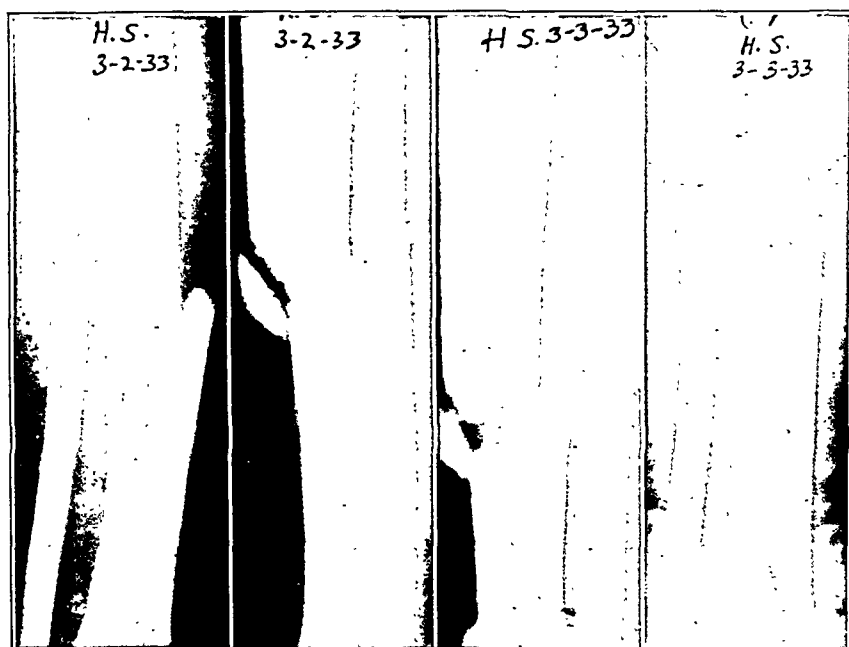


FIG. 12  
Case 3.



FIG. 13  
Case 4.



FIG. 14

Case 5.

and proximal portions of the plaster are connected by another plaster. When this has been accomplished, the two piano wires, the U-shaped supports, the plaster, and the distal and proximal portions of the tibia are all one and move as one. Regardless of position, the fracture cannot be displaced. The upper portions of the U-shaped supports are now removed, leaving the terminal portion of the U support to maintain the tension on the piano wires (Fig. 9). The patient may be allowed up in a couple of days, and the surgeon need have no worry as to displacement.

The site of insertion of the wires is dressed at the time of the operation, but not again until all dressings are removed. If the fracture is compound, a window may be cut in the plaster without danger of displacement.

The new U-shaped supports greatly facilitate the treatment. They are almost instantly adjustable for any width. Two supports are all that are necessary, since all but the terminal portions of the U are removed as soon as the plaster is firmly set. The frame described herein (Fig. 1) is not absolutely necessary, but is certainly a great convenience.

The following points are claimed for this treatment:

1. A minimum of asepsis is required.
2. Mechanically, the treatment is easy of execution.
3. Reduction and alignment are easily obtained.
4. Having obtained reduction, the surgeon is assured that no displacement can occur.
5. The patient can become ambulatory almost immediately.

# OPERATIVE TREATMENT OF SACRO-ILIAC DISEASE

## ANALYSIS OF CASES AND END RESULTS

BY CARL T. HARRIS, M.D., ROCHESTER, NEW YORK

Sacro-iliac disease, including sacro-iliac strains as well as destructive lesions, has become a relatively common diagnosis during the past ten years. This has been caused by a better understanding of the methods of diagnosis, particularly in differentiating between sacro-iliac and lumbosacral conditions. As a result of the work of Smith-Petersen, published in 1921, the operative treatment of sacro-iliac conditions has assumed a more prominent place among orthopaedic procedures. Other methods have been devised and advocated by Verrall, Campbell, Chandler, Albee, Gaenslen, and others. Considering the frequency of the diagnosis of sacro-iliac disease and its operative treatment, the reported end results seem few in number.

In 1926 Smith-Petersen reported thirteen cases of tuberculosis of the sacro-iliac joint treated by arthrodesis, with complete recovery in forty-six per cent., partial recovery in twenty-three per cent., and deaths in thirty-one per cent. The deaths were not immediate results of operation. Another series, comprising twenty-six cases and not including tuberculosis, was published by the same author in 1926. Complete recovery was secured in eighty-four and six-tenths per cent., partial recovery in seven and seven-tenths per cent., and failure in seven and seven-tenths per cent. A total of twenty-five out of the twenty-six returned to some form of occupation.

Gaenslen reported in 1927 a series of nine cases operated upon by his method, in which seven returned to work. Campbell in 1927 reported seven cases, in which he secured satisfactory results in five. The other two were too recent to warrant giving an end result. In 1929 Chandler reported five cases of trisacral fusion. Two secured complete relief, and three were too recent for a final report. Phelps and Lindsay in 1929 reported three cases operated upon by a modification of the method of Verrall, in which all had returned to work and were free from symptoms at the end of one year.

In this paper the writer wishes to report a series of sixty-seven consecutive cases of sacro-iliac disease, operated upon between the years 1923 and 1930, inclusive. For purposes of comparison and brevity of detail many of the tables are arranged in a manner similar to those in Smith-Petersen's report of 1926. All cases have been operated upon by the Smith-Petersen method with slight variations which have not changed the operative result.

Before going into the details of this report, it has seemed of interest to determine the frequency of operation in sacro-iliac disease. During this period in our private orthopaedic practice the diagnosis of sacro-iliac



disease was made in 296 cases, representing sixty-seven and one-half per cent. of the total number of patients examined because of low back pain. This percentage is high because of the fact that many of the patients were referred cases, in whom causes other than orthopaedic had been ruled out. In general surgical and internist practice the percentage would be much lower. No attempt was made to enumerate the large number of ward and clinic patients in this tabulation.

TABLE I  
FREQUENCY OF OPERATION

	<i>Male</i>	<i>Female</i>	<i>Total</i>	<i>Percentage</i>
Operation performed.....	22	28	50	16.9
Operation advised but not performed.....	29	16	45	15.2
Operation not advised.....	89	112	201	67.9
Total.....	140	156	296	100.0

Operation was advised in a little less than one-third of the cases seen, and performed in only about one-half of those in which it was advised.

In addition to the fifty private patients mentioned in Table I, this series includes seventeen ward patients operated upon during the same period of time.

TABLE II  
SOCIAL STATUS OF PATIENTS

<i>Class</i>	<i>Male</i>	<i>Female</i>
Private.....	9	28
Compensation.....	13	0
Ward.....	12	5
Total.....	34	33

In the above tabulation private and compensation patients have been separated, while in Table I they were grouped as private cases.

The youngest patient was thirteen years of age, with the diagnosis of tuberculosis of the sacro-iliac joint. The oldest patient was seventy-four years of age, with a chronic strain superimposed upon a degenerative arthritis, totally incapacitating her. The average was thirty-four and nine-tenths years for the men and thirty-two and three-tenths years for the women. Sacro-iliac disease has occurred in this series almost uniformly during the most productive years of life.

Histories obtained at the original examinations gave the following causes for the sacro-iliac condition.

TABLE III  
PRECIPITATING CAUSE OF DISEASE

	<i>Number</i>	<i>Percentage</i>
Fall.....	13	19.40
Lifting.....	18	26.87
Automobile accident.....	3	4.48
Infectious process.....	3	4.48
Pregnancy.....	3	4.48
Undetermined.....	27	40.29
Total.....	67	100.00

The undetermined causes occurred largely in those patients who had had symptoms for a period of years. The duration of symptoms before operation varied from one day to eleven years. The average duration was eighteen and three-tenths months.

Pain was the one common complaint in all cases. The localization varied somewhat.

TABLE IV  
LOCALIZATION OF PAIN

	<i>Number</i>	<i>Percentage</i>
Sacro-iliac region (unilateral) . . . . .	53	79.1
Sacro-iliac region (bilateral) . . . . .	12	17.9
Lumbosacral region . . . . .	1	1.5
No back pain . . . . .	1	1.5
Thigh (posterior) . . . . .	55	82.0
Lower leg . . . . .	20	29.8

In ten of the twelve cases having bilateral sacro-iliac pain, bilateral sacro-iliac fusions were performed.

The two principal findings were localization of pain to the sacro-iliac region, and extension of pain down the posterior surface of the thigh, reaching the lower leg in only thirty per cent. of the cases. The severity of the pain varied from a dull ache in the chronic cases to extreme pain, requiring large doses of morphin, in the acute cases. The greatest pain noted was in a patient having a definite infectious process.

Physical examination revealed the following findings.

TABLE V  
LOCALIZATION OF TENDERNESS

	<i>Number</i>	<i>Percentage</i>
Lumbosacral region . . . . .	12	17.9
Sacro-iliac region (unilateral) . . . . .	51	76.1
Sacro-iliac region (bilateral) . . . . .	12	17.9
Anterior abdominal . . . . .	15	22.3
Pain on iliac crest pressure . . . . .	12	17.9
No tenderness . . . . .	3	4.5

The more inconstant findings,—such as muscle atrophy, fibrillary twitching, slight sensory disturbance, etc.—are not enumerated, although they are important as diagnostic aids. In the eighteen per cent. of cases showing some tenderness over the lumbosacral region, the maximum tenderness was over the sacro-iliac region and at the sciatic notch. The tenderness on pressure over the anterior abdominal wall (John Baer's sacro-iliac point) is noteworthy. These cases show only seventeen and nine-tenths per cent. having pain on pressure over the iliac crests, in comparison with fifty-two per cent. in Smith-Petersen's group. Pain on iliac crest compression is a valuable diagnostic sign; its absence, however, does not exclude sacro-iliac disease.

Motions of the back were limited in all cases. Varying degrees of spasm of the erector spinae groups of muscles were found in the majority of cases. Eighteen (26.8 per cent.) of these showed a definite list to one

side. The occurrence of the list toward or away from the affected side was about the same, and the writer was unable to attach any diagnostic significance to the direction of the list. Motions of the back were more free with the patient sitting than when he was standing. This agrees with previous observations.

TABLE VI  
LIMITATION AND PAIN ON MOTION

	<i>Number</i>	<i>Percentage</i>
Limitation of straight leg raising:		
Unilateral . . . . .	37	55.2
Bilateral . . . . .	26	38.8
No limitation . . . . .	4	5.9+
Pain on straight leg raising:		
Unilateral . . . . .	41	61.2
Bilateral . . . . .	20	29.8
No pain . . . . .	6	8.9+
Pain on hip and knee flexion . . . . .	8	11.9
Pain on adduction and internal rotation with flexion of hip and knee . . . . .	15	22.3

Straight leg raising,—*i.e.*, flexion of the hip with the knee in full extension—was limited in all but six per cent. of the cases, and gave pain in all but nine per cent. In the majority of cases where there was bilateral limitation and pain on this manoeuver, the pain was referred to the affected joint.

Pain on flexion of the hip with the knee flexed was elicited in the extremely acute cases. A short period of rest in bed, usually on a Bradford frame, was sufficient to rule out disease in the lumbosacral region.

Hyperextension of the hip on the affected side was not carried out in a sufficient number of cases to warrant any conclusions in this report. The sign is apparently present frequently and may well serve as a diagnostic point.

Pain on forcible adduction and internal rotation of the hip, when both hip and knee were flexed, caused discomfort and pain in twenty-two and three-tenths per cent. of the cases, which places this as one of the important diagnostic signs. The reverse motion of abduction and external rotation was not as constant in producing pain, and it is not deemed of as much importance.

Stereoscopic roentgenograms were taken in all cases.

TABLE VII  
ROENTGENOGRAPHIC FINDINGS

	<i>Number</i>	<i>Percentage</i>
Sacro-iliac region:		
Destruction . . . . .	11	16.3
Irregularity . . . . .	39	58.2
Increased density . . . . .	38	56.7
Lumbar spine changes . . . . .	10	14.9

In the eleven cases showing destruction in the joint, a definite lesion was found at operation in nine (13.4 per cent.). In cases where symp-

toms had been present for a long period of time, increased density about the joint was noticed. On the other hand, in over sixteen per cent. of the cases, increased density was found in the side opposite to that in which the symptoms occurred. The finding of irregularity and increased density seems to be of questionable value in the determination of sacro-iliac disorders. The changes in the lumbar spine consisted of marked congenital variations or degenerative arthritis, which were not considered to be the cause of the complaints.

Other forms of orthopaedic treatment were carried out in many cases before operation was advised.

TABLE VIII  
PREOPERATIVE TREATMENT

	<i>Number</i>	<i>Percentage</i>
Sacro-iliac belt . . . . .	40	79.1
Back brace . . . . .	3	
Special corset . . . . .	2	
Rest in bed . . . . .	11	
Manipulation and plaster spica . . . . .	4	
Manipulation without plaster spica . . . . .	1	20.9
No treatment . . . . .	14	

In addition to the above methods, heat, massage, and exercises were given to many of the patients. Rest in bed in these cases was carried out over a period of weeks with partial relief of symptoms, which later returned. Manipulation under anaesthesia in the five cases relieved the discomfort for a period of a few weeks or months, followed by a return of symptoms. Although manipulation and a long period of recumbency may relieve the symptoms in some cases, the writer believes that the quickest and most certain method of relief lies in operative treatment. The shortest period of palliative treatment was one week; the longest, five years; the average was four and six-tenths months. In fourteen (20.9 per cent.) cases, operation was performed within a few days after the first examination.

The posterior Smith-Petersen incision was used throughout this series. The motor saw was discarded after the first case. The block of bone can be cut out easily with thin sharp osteotomes of varying widths. The use of osteotomes does not require as large an incision in the soft parts as when the motor saw is employed. The point at which the joint line is reached can usually be ascertained by the change in vibration of the chisel and the change in pitch of the sound, as the wooden mallet strikes the chisel. The average size of the bone block employed was one by one and a half inches, measured on the face of the ilium.

TABLE IX  
SACRO-ILIAC JOINTS FUSED

	<i>Number</i>	<i>Percentage</i>
Unilateral . . . . .	57	85
Bilateral . . . . .	10	15
Refusion . . . . .	3	4.5

In the cases where a bilateral fusion was performed, symptoms and physical signs pointed to definite lesions on both sides. In six cases both sides were fused at one operation. In the other four a period of at least two weeks intervened between operations.

Refusion was performed in three cases, due to a return of the original symptoms and signs. In these cases at the second operation the original fusion seemed to be solid, the depressed area in the ilium had entirely filled in, and no motion could be found. The symptoms disappeared following the second operation. No satisfactory explanation has been found for this seeming discrepancy.

No definite pathology or mobility was found in fifty-six (83.6 per cent.). Pathology was present in nine (13.5 per cent.). Excessive mobility occurred in two (2.9 per cent.). One of these was a far advanced tuberculosis of the sacro-iliac joint. The other followed a crushing fracture of the pelvis.

The after-care changed gradually throughout this series. In the first twenty-two cases a plaster spica was applied. Since August of 1927 plaster has been omitted. The length of postoperative care in this series can be definitely divided into two groups.

TABLE X  
LENGTH OF ACTIVE POSTOPERATIVE TREATMENT

	Number	<i>Aver. no. of weeks after operation</i>
Fusion with plaster spica . . . . .	22	28
Fusion without plaster spica . . . . .	39	14.7
Unable to follow . . . . .	6	

The writer believes that immobilization in plaster prolongs convalescence and delays the return to moderate activity.

The period of recumbency has been reduced from approximately twelve weeks to three and one-half weeks. The longest period was six months; the shortest, three weeks; the average was seven and one-half weeks. This average is higher than it should be, due to the twenty-two cases which were in plaster for a period of twelve weeks or more.

In the transition period between the use of plaster spicas and the shorter period of recumbency, thirteen cases received additional temporary support by the insertion of two beef-bone screws, parallel to the edge of the graft and about one centimeter distant from the edge of the graft, extending through the ilium well into the sacrum. Roentgenograms showed these to be absorbed in from three to six months. This procedure apparently did not influence the result in any way, and it has been abandoned.

Physiotherapy, in the form of heat and massage, was used in nearly fifty per cent. of the cases for a few weeks after discharge from the hospital. The larger proportion of the women wore corsets, either with or without a special sacro-iliac belt attached. A few of the men contin-

ued to wear a sacro-iliac belt which they had used prior to operation. The belts were discontinued gradually.

The end results cover periods from fifteen months to eight years following operation.

TABLE XI  
TOTAL RESULTS

	<i>Number</i>	<i>Percentage</i>
Free from symptoms . . . . .	46	68.65
Partial relief . . . . .	12	17.90
No relief . . . . .	2	3.00
Unable to trace . . . . .	6	8.90
Dead . . . . .	1	1.5

The cases listed as having received partial relief stated that the "old pain" had disappeared, and they complained of only indefinitely localized low backache without radiation. A few complained of pain in the scar for several months. Two cases have experienced no relief, but reoperation was not possible. The immediate results in the six cases which could not be traced were the relief of pain and the absence of symptoms. Five left the hospital symptom-free. One was discharged early against advice. One patient died of a generalized tuberculosis three months after operation. This man had an active pulmonary tuberculosis at the time of operation. Fusion was performed on account of the severe pain, unrelieved by other methods.

Referring to a former classification, there were eleven cases in which definite anatomical pathology was found. Fifty-six showed no changes in the joint at operation. The comparative results in these two classes are interesting.

TABLE XII  
COMPARATIVE RESULTS

	PATHOLOGY		NO PATHOLOGY	
	<i>Number</i>	<i>Percentage</i>	<i>Number</i>	<i>Percentage</i>
Free from symptoms . . . . .	7	63.63	39	69.64
Partial relief . . . . .	2	18.19	10	17.86
No relief . . . . .	0	0.00	2	3.57
Unable to trace . . . . .	1	9.09	5	8.93
Dead . . . . .	1	9.09	0	0.00
Total . . . . .	11	100.00	56	100.00

The percentage of results is essentially the same, inasmuch as the one patient who died was relieved of all back symptoms for the remaining three months of life.

Active tuberculosis of the sacro-iliac joint should be treated by fusion, providing that the general physical condition is not a contra-indication. The presence of necrotic material in or about the joint has not hindered the process of fusion in our cases, and the end results have been as satisfactory as in the patients having a sacro-iliac strain.

Relief was secured in about eighty-two per cent. of the cases with anatomical pathology, and in about eighty-seven and five-tenths per cent. without anatomical pathology. The latter group with physiological pathology (if one may use that term) is the more common and, perhaps, the more important. If these percentages were figured on only the number of patients who were followed, ninety-six per cent. of the physiological cases would show relief. The writer believes, therefore, that considerable relief may be expected in at least ninety per cent. of all cases.

Sixty patients (89.2 per cent.) can be classified as to their ability to return to work. These percentages are based on the total number of patients (sixty-seven), and include those who could not be traced and the one who died.

TABLE XIII  
FUNCTIONAL ABILITY

	<i>Number</i>	<i>Percentage</i>	
Returned to former work:			
Private and Ward.....	38	56.6	} 71.5
Compensation.....	10	14.9	
Returned to lighter work:			} 83.2
Private and Ward.....	6	8.9	
Compensation.....	2	2.8	
Reported unable to work:			
Private and Ward.....	3	4.5	} 6.0
Compensation.....	1	1.5	

Basing these percentages on the sixty cases followed for a year or more, eighty per cent. were able to return to former work, thirteen and four-tenths per cent. to lighter work, and six and six-tenths per cent. reported that they were unable to work. An interesting point shown here is that the proportionate results between compensation cases and private and ward cases is the same. This was due, the writer believes, to the careful selection of compensation cases, excluding those who seemed anxious to secure an easy income by malingering, and those who had a definite traumatic neurosis.

Many classes of workers were represented, but they have been divided into three groups.

TABLE XIV  
TYPE OF WORK

	<i>Number</i>	<i>Percentage</i>
Office.....	13	19.4
Housework.....	22	32.8
Industrial.....	25	37.3

Office workers included telephone operators, school teachers, clerks, etc. Housework varied from full-time active work to activities more social than laborious. Industrial work included plumbers, truck drivers, carpenters, and farmers, as well as day laborers.

The three cases in which a refusion was performed returned to work without symptoms. All three types of work were represented by these patients.

In two instances where a bilateral fusion was performed, it is interesting to note, the patients later went through an uncomplicated pregnancy and delivery without return of symptoms.

#### FINDINGS AND CONCLUSIONS

1. The chief value of roentgenograms is in the determination of a destructive lesion. Their value is questionable in other types of sacro-iliac disturbance.

2. A large percentage of patients were returned to work, eighty per cent. to their former occupation, and thirteen and four-tenths per cent. to a lighter form of work. Mortality was one in sixty-seven (1.5 per cent.); failure (unable to work) six and six-tenths per cent.

3. Sacro-iliac fusion is a satisfactory method of treatment both in strains and destructive lesions of the sacro-iliac joint.

4. Operation should be advised if, after a period of palliative treatment, the symptoms fail to subside or return after work is resumed. This applies particularly to the laborer who finds it impossible to change to a lighter form of occupation.

5. Fusion of the sacro-iliac joints apparently does not interfere with obstetrical delivery or render it more difficult.

6. Fixation in plaster, either with or without operation, prolongs the period of disability.

A considerable portion of this work has been done with the cooperation of Ralph R. Fitch, M.D.

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## EXPERIMENTAL PRODUCTION OF ARTHRITIS BY ARTIFICIALLY PRODUCED PASSIVE CONGESTION\*

BY MAURICE A. BERNSTEIN, M.D., F.A.C.S., CHICAGO, ILLINOIS

This article is a report on the experimental production of the lesions of chronic arthritis and the formation of new bone in dogs by means of artificially produced venous stasis.

So many factors are involved in the etiology of hypertrophic arthritis, or indeed in any type of arthritis, that any attempt directed towards the discovery of any proven causative influence is valuable.

The results of venous stasis in various parts of the body have been studied for many years. Much is yet to be learned. Common conditions almost invariably resulting from venous obstruction are sclerosis with atrophy, anaemia, and disturbance of calcium metabolism. In bone, or where osteoblastic cells occur, disturbances of ossification appear. In other tissues—as the kidney, for instance—marked sclerosis and atrophy are the rule.

Joint changes observed in hypertrophic arthritis are often suggestive of circulatory disturbances. Degenerative changes in the joints are the result of active congestion, such as is seen in the later stages of acute hyperaemia. Proliferative changes are observed in chronic inflammation with stasis. Vasomotor spasm acting through the sympathetic nervous system has also been responsible for joint changes.

Alterations in bones and in joints are often the result of cardiovascular and pulmonary diseases. Clubbing of the fingers or periarthritic thickenings in the terminal phalanges are noted in mitral stenosis and in chronic emphysema. Changes in the shafts of the long bones of the legs and in the smaller bones of the feet of a hypertrophic nature are noted as a result of varicosities.

Although hypertrophic enlargements of the transverse processes of the fifth lumbar vertebra are generally attributed to congenital causes, may they not be due to passive congestion resulting in osteogenesis? This stasis may be brought about by pelvic inflammation, tumors, enlargement of the gravid uterus, and also as a result of distensions of the caecum in chronic constipation causing interference in the hypogastric venous circulation.

Reasoning along these lines, it seemed to me highly probable that passive congestion or venous stasis was a factor in osteogenesis or new bone formation. In the furtherance of this idea I performed the following experiments.

In February and March of 1930, I operated on five dogs at the laboratories of the Northwestern University Medical School, through the courtesy of Dr. A. C. Ivy.

\* Read before the Chicago Surgical Society, March 3, 1933.



FIG. 1

Upper half of illustration shows the intervertebral space filled in by cartilage. This cartilage has replaced the fibrous tissue of the annulus fibrosus fibrocartilaginous intervertebralis and the nucleus pulposus and has extended beyond the intervertebral disc.

that the veins below the ligatures dilated immediately to about twice their normal size. All five dogs of this series were subjected to this same technique.

Dog 1, an adult male, died within four days after operation due to hemorrhages from the bowels. On postmortem examination it was found that there was considerable obstruction to the venous circulation.

The other dogs lived for two years—that is, until the first part of February, 1932—when they were killed, and their lower thoracic and lumbar spines removed for study. Each dog was roentgenographed at frequent intervals, from a period three months after operation until disposed of. The changes shown in the roentgenograms of some of the animals were those of rarefaction and decalcification, with loss of continuity of the bony outline at the anterior margins of the bodies of the vertebrae from the twelfth thoracic to the fifth lumbar.

The dogs were anaesthetized and prepared aseptically for laparotomy. By the abdominal route the lumbar veins were exposed at their junction with the venae cavae. The visceral peritoneum was split by blunt dissection so as not to injure the sympathetic nerves, venae cavae, and abdominal aorta. Every precaution was taken to avoid injury to the nerve supply to the veins. Silk ligatures were placed on the veins, one above the other, to assure complete ligation. It was observed

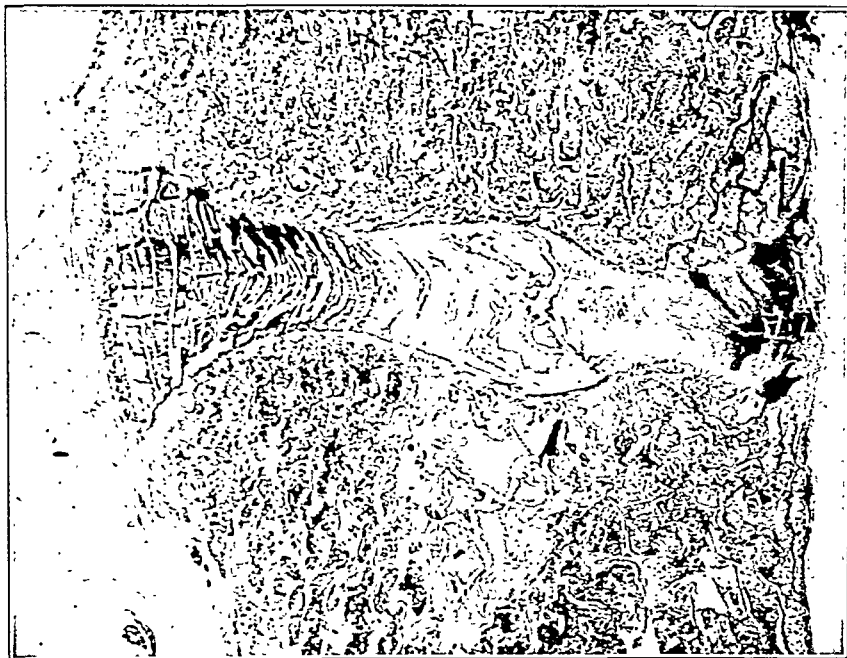


FIG. 2

Shows two adjacent vertebrae with intervening intervertebral space. Note proliferation of cartilage cells, involving the nucleus pulposus, perforating the intervertebral disc, and extending into the body of the vertebra below.

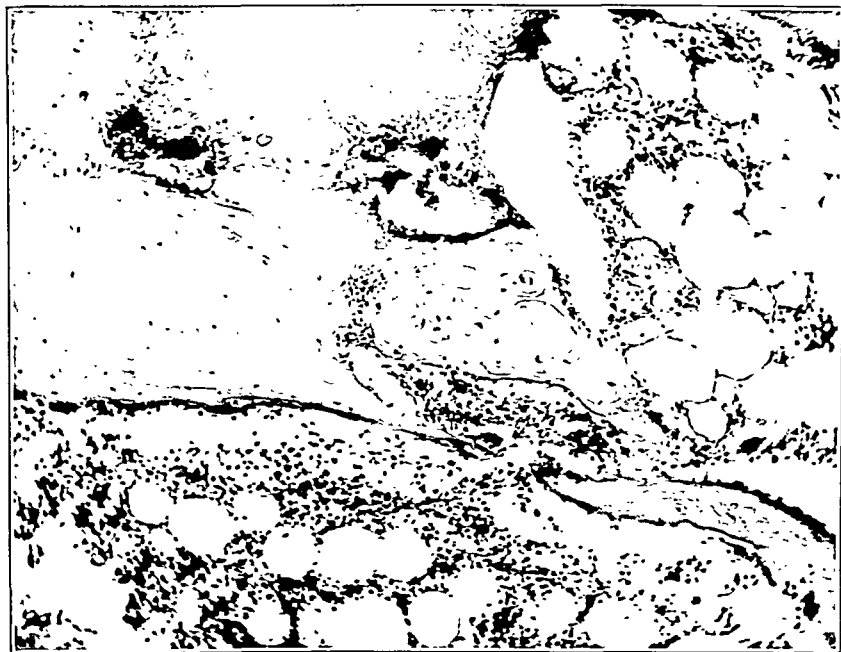


FIG. 3

Same as Fig. 2 ( $\times 160$ ), showing nests of cartilage cells bounded by mature bone. To the bone lamellae cling osteoblasts. Areas of bone absorption and new bone formation are in evidence.

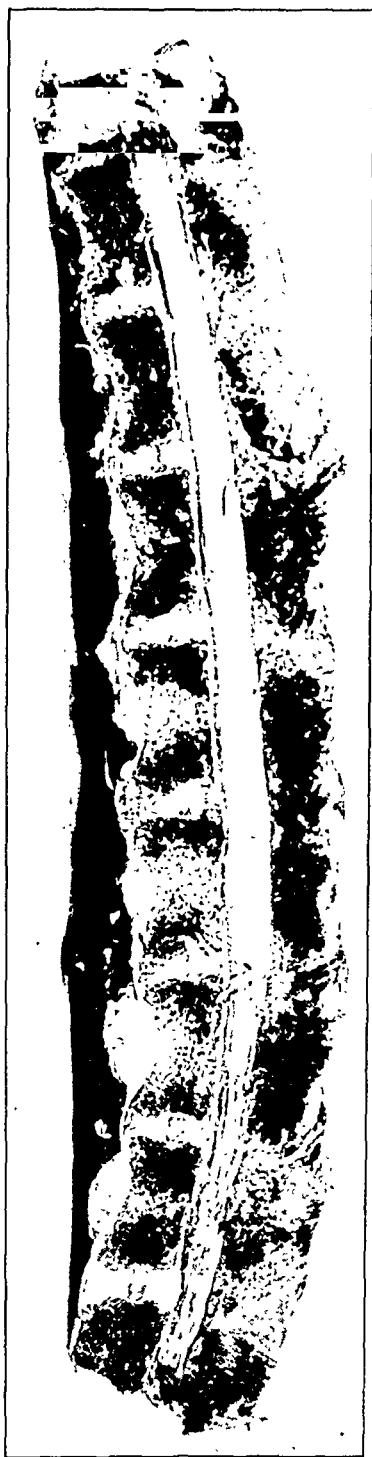


FIG. 4

Bisected spine of Dog 5. It includes all of the lumbar spines and two and one-half of the dorsal. From above upward there appears a tumor-like bony outgrowth on the anterior surfaces of the vertebrae. This outgrowth of bone seems to extend from each body outward and forms a nodule which extends from one articular surface to the other. These nodules consist of young osteoid tissue with a loose fibrous stroma.

In the gross specimen, the spine of Dog 2 showed yellow patches in the marrow of the bodies, close to the articular margin. These patches were more or less irregular in outline and harder in consistency than the uninvolved bone. Some of these patches extended through the epiphysis and involved the nucleus pulposus and the annulus fibrosus fibrocartilaginous intervertebralis (Fig 1). Dog 3 showed only one lesion. This was a herniation, or, to be more exact, a proliferation of cartilage cells into the body of the third lumbar vertebra (Fig. 2). This change is unlike that described by Schmorl, in which the gelatinous nucleus pulposus herniates or is displaced as a result of pressure.

Dog 2 and Dog 4 showed practically the same changes. Dog 4 showed proliferation of cartilage in the intervertebral space to a greater degree than occurred in Dog 2. Islands of cartilage cells replaced fibrous tissue in the intervertebral spaces. The proliferating cartilage extended into the nucleus pulposus, forming nests of cartilage cells. Some of the bone trabeculae in the bodies underwent resorption with replacement by fibrous tissue and newly formed osteoid tissue.

Dog 3 (Figs. 2 and 3) showed in the intervertebral space between the second and third lumbar vertebrae a proliferation of cartilage cells, filling the intervertebral space, displacing the fibrous tissue at the periphery, and obliterating the nucleus pulposus. The intervertebral disc at the center of the upper border of the third lumbar vertebra was perforated by the cartilage-cell formation and these cells extended into the body of the vertebra, displacing the bone trabeculae and causing bone absorption at the point of cartilage extension. Giant cells were seen along the edges of the bone trabeculae. There was little change present in the spine of this dog beyond that stated above. The difference

These nodules consist of young osteoid tissue with a loose fibrous stroma.

between a herniated nucleus pulposus and the condition found above is that the cartilage proliferation filled most of the intervertebral space, perforated the intervertebral disc, and extended downward into the body of the vertebra. The herniated, or rather the proliferated, cartilage tissue does not resemble the tissue of the nucleus pulposus.

Lang<sup>5</sup> states "that in far advanced arthritis deformans, the so called cartilage nodules are observed; these are situated in the marrow spaces of the spongy bone". According to Pommer and Lang the cartilage nodules can originate in two ways: first, as callus resulting from microscopic fractures; and second, as fragments of joint cartilage that are broken off and transported as emboli along the capillaries and lymph vessels and grow where they lodge.

In the specimens of Dogs 2 and 3, the proliferation or extension of cartilage cells occurred at the points where the intervertebral disc was perforated. The cartilage cells extended from the region of the intervertebral space, where cartilage cells normally are found.

Dog 5 showed the greatest amount of change. Before the dog was killed, he experienced some difficulty in walking. He held his spine rigid and walked carefully. Muscle rigidity and immobility of the spine were present. On physical examination there appeared to be a marked infiltration of the tissues of the lower regions of the spine.

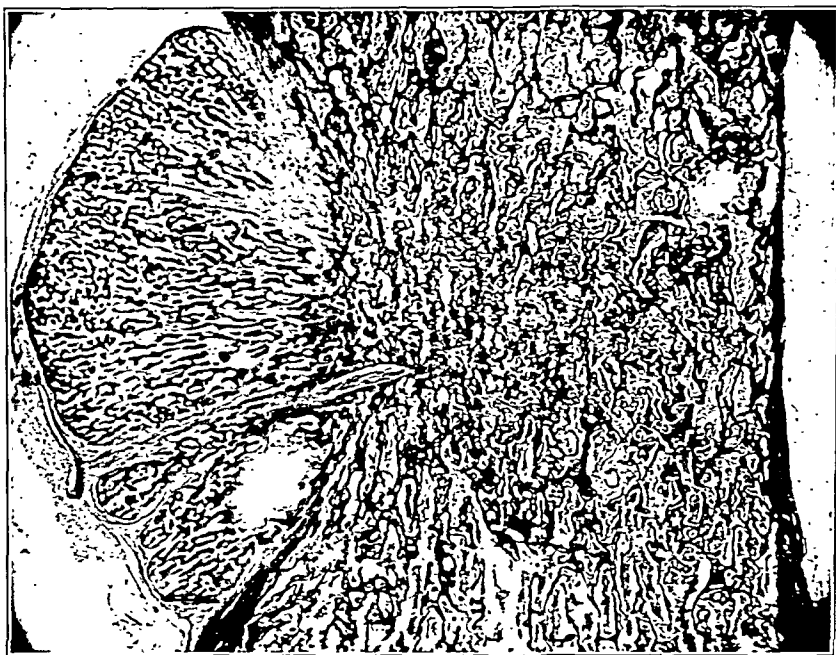


FIG. 5

Same as Fig. 4, showing one of the vertebrae with new bone formation on the anterior margin. Note the separation of these bony masses by fibrous tissue strands or septa.

The entire spine was removed for study and was bisected throughout its entire length (Fig. 4). Bony processes were found on the anterior surface of the twelfth thoracic vertebra and on each of the five lumbar vertebrae. This newly formed bone was well defined on the twelfth vertebra, and the bony processes on the other vertebrae progressively increased in size, so that those on the third and fourth lumbar vertebrae were of considerable size (Fig. 5). These processes seemed to extend out from the middle of the body, projecting beyond the surface of the vertebra and obliterating the anterior vertebral border. The color was pinkish yellow. Each bony process extended from one articular margin to the other, so that the full length of the vertebra on the anterior surface was covered by this osteoid tissue. These bony masses were almost alike in form, the third and fourth lumbar vertebrae having the largest growths upon them. There appeared to be no bridging across the intervertebral spaces from vertebral border to adjacent vertebral border, such as one sees in osteo-arthritis. The processes seemed to have originated from within, and to have extended outward beyond the surface of each body. The bony processes in the third and fourth lumbar bodies seemed to be divided into two or three bony masses by connective tissue septa, which could be made out with the naked eye.

On microscopic examination these bony masses were found to be composed of osteoid tissue. This tissue was arranged in masses separated by a loose fibrous stroma (Fig. 6). In some places bone trabeculae could be seen to project into the fibrous stroma, and these trabeculae were lined with osteoblasts (Fig. 7). The processes in the third, fourth, and fifth lumbar vertebrae appeared to be quite far advanced and islands of mature bone were abundant. The osteoid tissue showed no lime deposit, staining red with hematoxylin and eosin. The twelfth thoracic and the first lumbar vertebrae showed more progressive changes. The young osteoid tissue was not so far advanced in the development as it was in the lower lumbar vertebrae. Here the fibrous stroma was more abundant. However, the fibrous tissue was quite generally distributed, and was permeated by the osteoid tissue which spread out in every direction. In the center of the bodies the mature bone showed regions of bone absorption and this same variety of osteoid tissue lying between a loosely arranged fibrous stroma.

One received the impression that there were three processes actively present,—first, bone absorption (an osteolysis); second, a fibrous tissue proliferation; and third, a metaplasia of connective tissue with new bone formation (osteogenesis).

It was decided to attempt, by passive congestion, to produce changes in a joint that could be studied with more ease than could the joints of the spine. The knee was selected, therefore, and in June, 1931, Dog 6 was operated upon by ligation of the branches of the femoral vein above the knee joint.

The knee was prepared as usual by shaving and aseptic measures. Ether anaesthesia was used. An incision was made on the inner side of



FIG. 6

Same as Fig. 5 ( $\times 40$ ), showing the bony structure and fibrous tissue strands which separate the osteoid tissue.

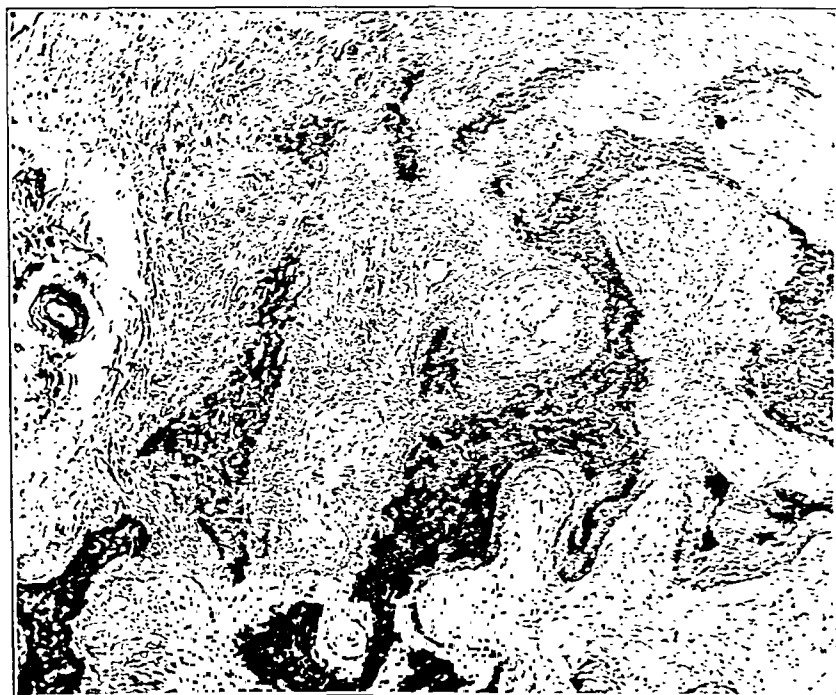


FIG. 7

A portion of Fig. 6 ( $\times 80$ ). Note the osteoid tissue and mature bone. Note also the extensive fibrous stroma, the bone trabeculae, and osteoblasts clinging to the surface. There is also present considerable vascularization.



the joint above the patella. The branches of the femoral vein, which drain the knee, were isolated and ligated. No oedema or apparent disability followed this operation. This dog (Dog 6) was kept alive until March 1932. A roentgenogram of both knees was taken in the early part of March. The operated knee showed some indefinite changes on the articular surface of the femur,—a rarefaction in the outer condyle. There was no evidence of destruction of the articular cartilage and no new bone formation. The patella presented irregularity of its margins with a loss of surface continuity.

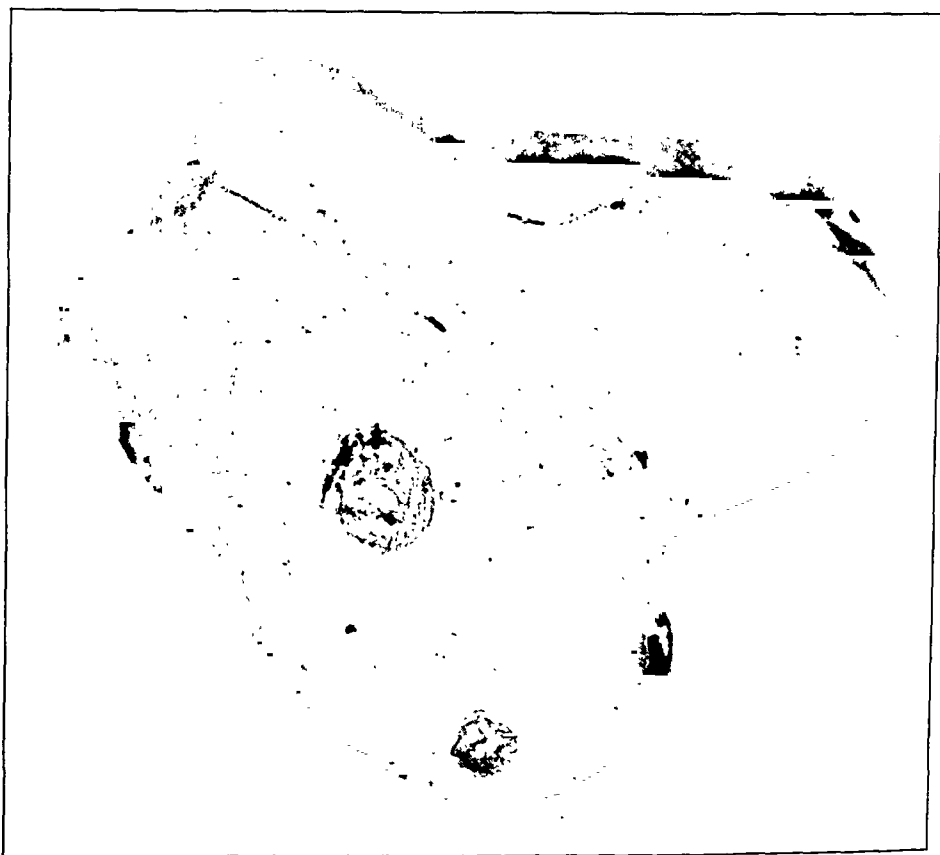


FIG. 8

Photograph of condyles of femur showing three lesions. The one on the outer condyle to the left and below shows a rounded depressed area of the articular cartilage, with the subchondral vessels showing through. The small horseshoe-shaped area on the inner side of the condyle contained a necrotic bit of material; after its removal it left a defect as in Fig. 9. The area above the condyles was discolored but not depressed and showed the vessels through.

The dog was then killed and both knee joints were opened for study. The knees were opened by cutting the quadriceps tendon; the patella was dissected downward; all care was used not to injure the articular cartilage surfaces.

The knee that was operated on presented a striking appearance. The synovial membrane and fat pad showed congestive changes; these were evident by hyperemic areas at the borders of attachment to the

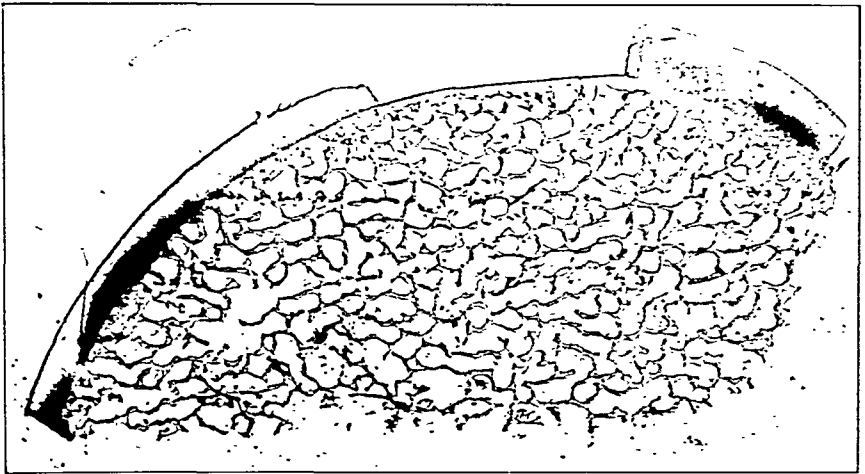


FIG. 9

\* Photograph of the articular margin of the femur in Fig. 8, showing a defect which looks like an artefact. This is due to the removal of the necrotic mass, leaving a thin portion of cartilage covering the bone.

surface, close to the intercondylar notch, were seen patches of fine web-like granulation tissue. This pannus spread over the articular cartilage of the outer condyle bordering on the attachment of the crucial ligament and extended to a defect in the cartilage to which it was attached at one point. The fat pad also showed areas of increased vascularization. These appeared as red streaks. The congestion extended to the ligamentum mucosum at the intercondylar notch.

The articular cartilage on the external condyle of the femur showed three lesions (Fig. 8). One lesion, lying immediately above the lower surface, was about two centimeters in circumference, round, depressed, with edges well defined, and slightly elevated. The cartilage on the surface appeared as if it had been shaved off or worn through, leaving a bluish surface through which could be seen the subchondral vessels.

A second lesion was seen on the inner surface of the condyle, at the attachment of the crucial ligament. This lesion was punched out and contained a dark clot-like mass of necrotic material. When this was removed it left a definite defect, irregular in outline, with sharp borders. Pannus from the synovial membrane extended to the border of this defect.

The third lesion was in the region above the condyle and was not ulcerated or depressed, but was slightly discolored, bluish gray, and the vessels of the subchondral bone could be seen through it.

Microscopic examination of the lesion on the inner border of the external condyle revealed a loss of continuity of the surface (Fig. 9). There appeared in this area an absence of articular cartilage surface leaving a crater-like defect. A thin layer of cartilage still remained, covering the subchondral bone. The area looked very much like an artefact, but this was perhaps due to the wiping out of the necrotic ma-



FIG. 10

A portion of the articular cartilage of the knee joint ( $\times 40$ ), showing the articular surface markedly decreased in diameter. Note the perpendicular arrangement of the cartilage cells on the surface, the enlarged blood vessels, and the atrophied bone trabeculae. Compare with Fig. 11.

articular cartilage surface cells were destroyed, leaving a thin rim of cartilage covering the end of the bone (Fig. 10). This area bordered upon practically normal-appearing cartilage on both sides of the defect (Fig. 11). The surface cells in the depressed region lay perpendicular; those at the adjacent cartilage were parallel, showing that the surface cells were removed. In the subchondral region there were seen numerous blood vessels. The marrow spaces contained fat; there were no osteoblasts nor osteoclasts present. These defects were crater-like, and involved about four-fifths of the articular cartilage. A thin layer of cartilage yet remained and formed the base of the ulcer, which rested upon the decalcified, fatty, atrophic bone. In some places the cartilage cells were denucleated, and extended to the edges of the defect. The cells in the uninvolved region lay parallel to the surface, which is the normal arrangement of the superficial cells of the perichondrium. As the involved region was reached these surface cells disappeared, perhaps by chondrolysis, leaving the cells of the deeper strata perpendicular in arrangement. At this time no attempt at healing appeared, and no sign of inflammation was evident, excepting that the vessels in the bone below the cartilage were enlarged and numerous. The lesion in the center of the articular cartilage on the outer condyle of the femur was found where the greatest amount of pressure of apposing articular cartilage occurs. It may be possible that the thinning of the articular cartilage surface occurred first from softening as a result of circulatory disturbance; or, as Pommer states, from "loss of elasticity of the joint cartilage", or, according to Phemister<sup>3</sup>, as a result of

terial that filled it. In this region the surface cells were completely gone. The cells that remained covering the bony surface appeared shrunken and denucleated. The spongia showed an absence of lime salts, and the bone lamellae showed areas of osteolysis. The marrow spaces contained fat. In the other of the two areas the



FIG. 11

Same as Fig. 10; a different portion of the articular cartilage away from the depressed region shown in Fig. 10. Note the parallel arrangement of the surface cells of the perichondrium.

contact and pressure of, or wearing down of, the articular cartilage surface.

It is my belief that these defects, if permitted to progress, would eventually become covered over by fibrous tissue derived from the edges of the synovial membrane. This belief is based upon the changes which were found in the synovial membrane bordering on the ulcerations. The synovial fringes were hyperaemic, and thickened, and showed a tendency towards pannus formation. Also, the patella showed a degenerative change, in that its edges were irregular, and its surface presented a loss of continuity. Microscopically, it presented a loss of lime deposits, and atrophic bone trabeculae with fatty marrow spaces.

Thus, there were present a destruction or ulceration of the articular cartilage of the femur and a chronic hyperplastic synovitis. The changes in the articular cartilage of the femur were of a chondrolytic nature.

In March, 1932, two more dogs were operated on in a manner similar to that used for Dog 6. The branches of the femoral vein above the knee joint were ligated. The dogs were kept alive for two months and were then killed.

The knee of Dog 7 was then opened and showed (Fig. 12) a defect of the articular cartilage on the outer condyle of the femur. This defect was irregular in outline and bordered upon the synovial membrane surface, close to the intercondylar notch. Small grayish patches were present in the synovial membrane surface. These looked like calcified areas.



FIG. 12

Dog 7. Defect on outer condyle of femur produced by ligation of femoral vein branches. Dog was kept alive for two months. Note widespread calcified areas (the chalk-like flakes in the photograph).

spaces and in the fibrosus annulus intervertebralis. Islands of cartilage cells were seen in the bodies at their peripheries and below the intervertebral discs. In the spine of one dog there was a proliferation of cartilage into the body of the third lumbar vertebra and formation of osteoid tissue. In one dog masses of new bone were found on the anterior surfaces of five lumbar and one thoracic vertebrae. In this dog young osteoid tissue and new bone were present in the body and extended beyond the anterior surface. The changes were more pronounced in the lumbar vertebrae and corresponded to the region of the ligated veins.

Microscopically there was shown a proliferation of cartilage cells, and these cells were distributed irregularly through the bone trabeculae. Osteoblasts were present on the borders of the osteoid tissue, and in other regions nests of osteoclasts were evident. The marrow spaces contained fat, and the hemapoietic tissue was decreased in amount. In other regions the trabeculae appeared to be normal with some increase of the intercellular elements.

The dogs of this series were all kept alive for practically the same length of time,—that is, two years; so that the bone changes were of the same duration. Dog 6 and Dog 8 were the only animals kept alive for a

The synovial membrane itself showed hyperaemic areas. Microscopically there was present no inflammatory reaction in the articular cartilage, nor in the spongiosa. The bone trabeculae, however, appeared decalcified and atrophic and showed areas of degeneration. These changes were somewhat like those found in Dog 6.

Dog 8 developed a severe case of mange and died. The knee of this dog was not investigated.

#### SUMMARY AND CONCLUSIONS

In these experiments changes were produced of a regenerative nature in the spines, and of a degenerative nature in the knee joints of dogs. The changes in the spine were cartilage proliferation and new bone formation. In each of three dogs the changes took place in the intervertebral

shorter period,—*i.e.*, two to six months; so that in these dogs were not seen the advanced processes present in the others. One may deduce from these experiments that proliferation, or rather new bone formation, resulted from venous stasis. The control animals showed no such changes.

I wish to extend my gratitude to Dr. R. F. Zeit and Dr. A. C. Ivy for the materials used at Northwestern University Medical School, and the assistance given me in the furtherance of these experiments.

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## LEG LENGTHENING IN ADULTS

BY JOSEPH S. BARR, M.D., AND FRANK R. OBER, M.D.,

BOSTON, MASSACHUSETTS

The procedure known as leg lengthening has become standardized to such an extent that it is being used in most of the larger orthopaedic clinics. The original work of Codivilla<sup>1</sup> and Putti<sup>2</sup> gave proof that the operation was feasible. It remained for Abbott<sup>3</sup> to devise a simple dependable apparatus and to standardize the operative procedure. Since his first report, in 1927, of six cases successfully lengthened, the method has been used on literally hundreds of children. In well selected cases the operation has proved itself safe and worth while. However, a careful review of the literature reveals that the cases reported as lengthened by the Abbott method are, without exception, children under the age of sixteen. There are a few isolated case reports of malunited overriding fractures of the femur in adults being reduced by heavy skeletal traction, but no series of cases has been found in which shortening due to unequal growth of the legs was overcome.

Magnuson's<sup>4</sup> experimental work proved that about two inches could be safely obtained. The purpose of this paper is to report five young adult cases in which leg lengthening has been done. In each, the cause of the shortening was infantile paralysis.

Figure 1 shows the leg-lengthening apparatus as used at the present time. The technique of lengthening as used in these cases is essentially that of Abbott, but the apparatus has been altered somewhat. Each of

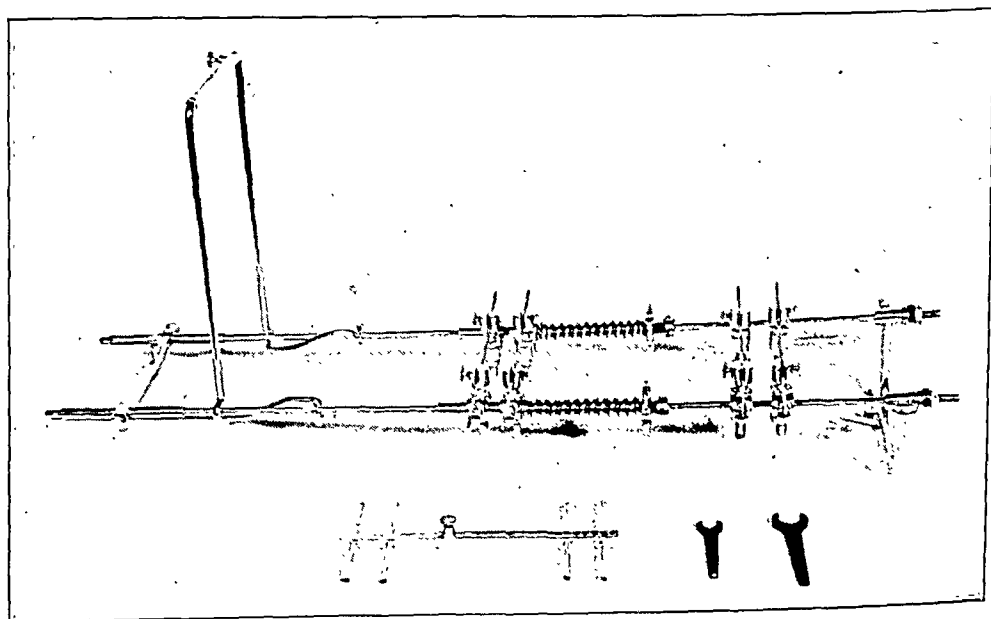


FIG. 1

Leg-lengthening apparatus.

the pins is movable at either end, so that any tendency of the bone fragments to angulate can easily be overcome by the proper adjustment.

The tendency of the foot to assume a position of equinus and valgus during leg lengthening has been noted by every one who has had experience with this procedure. This occurs in spite of tenotomy or lengthening of the tendo achillis and double osteotomy of the fibula. For this reason it is best to defer stabilizing operations on the foot until the leg lengthening has been done. The foot can then be placed in the correct weight-bearing position.

Case 4 in this series developed such an equinus during leg lengthening that a reconstructive operation on the foot was necessary. An ordinary foot rest will not prevent the occurrence of this deformity. To overcome this difficulty, a plaster boot, incasing the foot and extending up the posterior calf, has been tried in two cases. In addition, an attempt has been made to overcome the tendency to valgus deformity of the foot by turning up the outside turnscrew about one-eighth of an inch more than the inside one, which tends to force the foot into a little varus. This procedure has been successful in holding the foot in the correct position in the two cases in which it has been used.

#### CASE REPORTS

**CASE 1. M.E.W.** This patient was a single white girl of twenty. She was first seen on June 5, 1919. She had had infantile paralysis when two years old, involving chiefly the left leg. Progressive shortening of the leg occurred until, when seen in 1928, the left leg was found to be two and three-quarters inches shorter than the right, as measured from the anterior-superior spine to the sole of the foot. She used a long caliper brace and a two-inch cork high sole.

Leg lengthening was done on June 19, 1928, and at the same time transplant of the flexor communis digitorum to the os calcis was done. Abbott's method of leg lengthening was used. Convalescence was uneventful. On August 10, 1928, the leg-lengthening machine was removed and a cast applied. Union was somewhat delayed, due to slow callus formation, and the patient began to walk with a brace September 19, 1929. There was shortening of the leg of one-quarter of an inch at that time. In December 1929, the patient felt some pain in her left leg and x-rays showed a subperiosteal transverse fracture of the left tibia at the junction of the lower and middle thirds. On February 28, 1930, x-rays showed the fracture completely healed. On May 21, 1930, an osteotomy of the left tibia just below the knee was done to correct the knock-knee. Convalescence was uneventful. The patient was last seen September 14, 1931. The left leg was one-quarter of an inch short. She walked with practically no limp without a brace, but had not yet been able to completely discard it due to the weak quadriceps. She was much pleased with the result, as she was freed from the necessity of using a high sole and rarely used a brace.

**CASE 2. M.M.** This patient was a single white girl of twenty-nine, first seen on November 16, 1929. She had had infantile paralysis when thirteen months old, involving her left leg only. The patient wore a long brace with an inside sole plate and a shoe with a three-inch cork sole. The leg was three and one-half inches short, as measured from the anterior-superior spine to the sole of the foot. Most of the shortening was in the lower leg. There was sufficient quadriceps and hamstring power to justify an attempt to get rid of the brace and high sole by leg lengthening.

On December 2, 1929, leg lengthening was done after the method of Abbott. The lengthening was begun seven days after the operation and was stopped on February 1,



1930, at which time a gain of two and one-quarter inches had been made. The leg-lengthening machine was removed and a plaster cast was applied from the toes to the groin on February 15, 1930, which was worn for twelve weeks. When seen in November 1931, she was working, without apparatus, standing on her feet a great deal. She walked with her knee held quite stiffly, due to fifteen degrees' permanent knee flexion. This has been corrected by osteotomy of the upper end of the tibia. When last seen she was walking two or three miles daily without aid, except for occasional use of a cane. She was entirely satisfied with the result, as she had been enabled to discard a long brace and a heavy high sole by the operation. The leg was in good alignment, one and one-quarter inches short. As part of the shortening was compensated for by equinus of the foot, she was able to wear an ordinary shoe.

CASE 3. W. H. was a single white boy of eighteen. He was first seen on May 25, 1921. He gave a history of having had infantile paralysis when he was a year and a half old. Both legs were affected, but the left one had returned practically to normal. The right leg required a long brace. He was carried along under conservative treatment, physiotherapy, and exercises, and a long caliper brace on the right, until July 7, 1930, when a right erector spinae transplant (Ober<sup>3</sup>) was done. Postoperative recovery was uneventful, and on July 23, 1930, a Hoke arthrodesis and countersinking of the astragalus (Brewster<sup>6</sup>) was performed on the right foot. At the same time a plastic operation, after the method of Gill<sup>7</sup>, was done on the knee for recurvatum.

When seen on February 24, 1931, the foot was in good position; no hyperextension of the knee was permitted; the erector spinae transplant was functioning well; and the gluteus maximus and medius limp had practically been overcome. The right leg was found to be three inches short, and it was decided to do a leg lengthening. This was done on March 30, 1931, after the method of Abbott. A plaster boot, incasing the foot and extending up the posterior calf almost to the knee, was applied after the operation. This held the foot in neutral and prevented the occurrence of equinus deformity as the lengthening proceeded. The lengthening apparatus was removed May 28, 1931, and a plaster cast applied, which was removed December 2, 1931. The leg was quite solid in good alignment. There was no shortening,—*i.e.*, three inches had been gained in length. The patient is now walking about two miles daily, using a cane part of the time. He walks well and uses no apparatus.

CASE 4. G.S., an unmarried white girl of twenty-three, was first seen on June 11, 1930. She had had an insidious onset of paralysis of her right leg when nine months old. The patient wore a long, right, caliper brace and a shoe with a cork sole, three and a half inches high. The leg was four and one-eighth inches short, all but one and one-half inches of the shortening being in the lower leg. The quadriceps was strengthened by transplant of the sartorius and tensor fasciae femoris to the patella on October 17, 1930.

On November 14, 1930, the right leg was operated upon after the method of Abbott. The lengthening was begun eight days later. It proceeded smoothly, and the lengthening was stopped on December 30, 1930. The apparatus was removed on January 23, 1931, and a plaster cast applied from the toes to the groin. The cast was removed March 23, at which time it was found that union of the leg was quite solid. There was a total gain of two and five-eighths inches in length. The knee transplant functioned well. The foot, which before operation had been in very slight equinus, was now in forty-five degrees' equinus, making it practically impossible for the girl to wear a shoe. On May 25, 1931, a wedge osteotomy of the foot in the mid-tarsal region was done and a plaster cast applied. This was removed six weeks later and weight-bearing with crutches was started. When seen in January 1933, the right leg was found to be one and one-quarter inches short, measured to the sole of the foot. This was partially compensated for by the remaining mild forefoot equinus. She now walks without a brace or high sole, with the occasional aid of a cane. She is greatly pleased with the result.

CASE 5. M.H. This patient was a single white girl of twenty-six, who had infantile paralysis in 1908. About ten years ago an astragalectomy for a flail left foot was done

with an excellent result. She had three inches' shortening of the left leg, and walked with a marked short leg and gluteus medius limp.

On January 23, 1929, the left leg was lengthened after the method of Abbott. The apparatus was removed and a plaster cast applied April 11, 1929. She began weight-bearing about six months later. When last seen, August 6, 1931, there was one inch shortening of the left leg as measured from the anterior-superior spine to the sole of the foot. The foot was in excellent position, quite stable. She walked without apparatus in ordinary shoes. The gluteus medius limp was still present. She was well satisfied with the result, as she was enabled to discard an unsightly high sole by the operation.

The average period of disability due to the operation in this group of cases was nine months; the maximum was fifteen months; the minimum, five months. There were no deaths and no sepsis occurred. As compared with younger children, the lengthening must proceed a little more slowly and there seems to be a little more pain and discomfort during the lengthening. No case, however, required more than an occasional dose of morphin, and most of them required neither hypnotic nor sedative after the first week postoperative. Pain during the lengthening is usually referred to the lateral aspect of the ankle and dorsum of the foot, suggesting that the stretching of the peroneal nerve is the cause. One or two days' rest relieved the symptoms as a rule.

TABLE OF CASES

<i>Case</i>	<i>Age</i>	<i>Shortening</i>	<i>Lengthening Obtained</i>	<i>Complications</i>	<i>End Result</i>
1. M. W.	20	2¾ inches	2¼ inches	Fracture of tibia 1½ yrs. after lengthening	Good. Walks without apparatus.
2. M. M.	29	3½ inches	2¼ inches	None	Excellent. Patient discarded long brace and high sole.
3. W. H.	17½	3 inches	3 inches	None	Excellent.
4. G. S.	23	4½ inches	2⅝ inches	Foot developed marked equinus	Excellent. Patient discarded long brace and high sole.
5. M. H.	26	3 inches	2 inches	None	Good.

The proper selection of cases is of great importance. It does not seem worth while to lengthen a leg which has insufficient muscle power to discard a brace after the operation. It seems best suited to those cases which will be enabled by the lengthening, and other operations if necessary, to discard all apparatus on that limb.

It goes without saying that the cooperation between patient and surgeon should be perfect. The surgeon should explain the procedure to the patient as carefully as possible, estimating the period of disability as about one year. The dangers as well as the benefits should be weighed carefully and the patient should be allowed to decide without urging the case for or against lengthening.

In the small series here reported, no case has been "lost track of" or has been uncooperative. Each one has been enabled to discard a brace or high sole or both with consequent cosmetic and functional improvement. The follow-up examination has shown a satisfactory result in each case, and each patient has expressed himself as satisfied with the result.

#### CONCLUSION

From the experience gained with this small group of cases, it seems justifiable to conclude that leg lengthening in adults will yield gratifying results if the patients are properly selected and the technique of the lengthening and after-care is properly carried out.

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# ENLARGEMENT OF THE INTERVERTEBRAL DISC ASSOCIATED WITH DECALCIFICATION OF THE VERTEBRAL BODY: A COMPENSATORY HYPERTROPHY

BY BARCLAY W. MOFFAT, M.D., NEW YORK, N. Y.

*From New York Post-Graduate Hospital*

It has been noticed by all orthopaedic surgeons that a roentgenogram of the spine occasionally will show an increase in height of the intervertebral disc, this structure assuming a biconvex form. The significance of this change and the mechanism by which it comes about have not been investigated.

In the following five cases these changes in the shape of the intervertebral disc were most marked and were accompanied by decalcification of the vertebral bodies. These patients all came complaining of backache, following slight trauma in four cases, and none in the other. Beside the above changes, by x-ray there was found to be fracture of one or more vertebral bodies as the source of the pain complained of. It is logical to assume that these fractures were associated with the underlying condition in the spine which led to the decalcification and to the increase in size of the intervertebral disc.

These five cases are outlined below with a brief discussion of the etiological factor, where it could be determined, and the process taking place in the disc which caused it to assume biconvex to spherical shape. It seems a point worth noting that, in the absence of any local pathology, such as osteitis or neoplasm, a pathological fracture of the spine may take place through faulty metabolic processes.

**CASE 1.** Male, aged sixty-four, admitted August 5, 1928, complained of pain in the back for the past five years and in the hips for the past ten years. Examination was negative. Roentgenograms taken at this time are reproduced (Figs. 1 and 2). On December 19, 1928, patient was readmitted with paraplegia and loss of sphincter control. No x-rays could be taken at this time because of the patient's condition. Neurological examination made it probable that the man had sustained fresh fractures of the lumbar vertebrae with a transverse myelitis. He died of hypostatic pneumonia and a section of a portion of the spine, removed at autopsy, is shown (Fig. 3). A microscopic examination established a diagnosis of multiple myeloma.

**CASE 2.** Female, aged fifty-six, complained of pain in the middle of the back radiating about both sides of the abdomen, following a jolt while riding over an uneven road. Physical examination was negative except for tenderness over the first lumbar vertebra where compression fracture was found (Fig. 4). Patient died within a few days and autopsy disclosed rupture of the aneurysmal varix. A specimen of the spine was not obtained.

**CASE 3.** Female, aged sixty-one, admitted June 12, 1927, complained of pain in the back following a fall six weeks before. Examination was negative except for evidence of root involvement over the distribution of the first lumbar vertebra (protopathic) and twelfth dorsal and second lumbar vertebrae (epicritic). Roentgenograms taken at this time are reproduced (Figs. 5, 6, and 7). The basal metabolic rate was plus five per cent. Sugar tolerance test was slightly diminished.

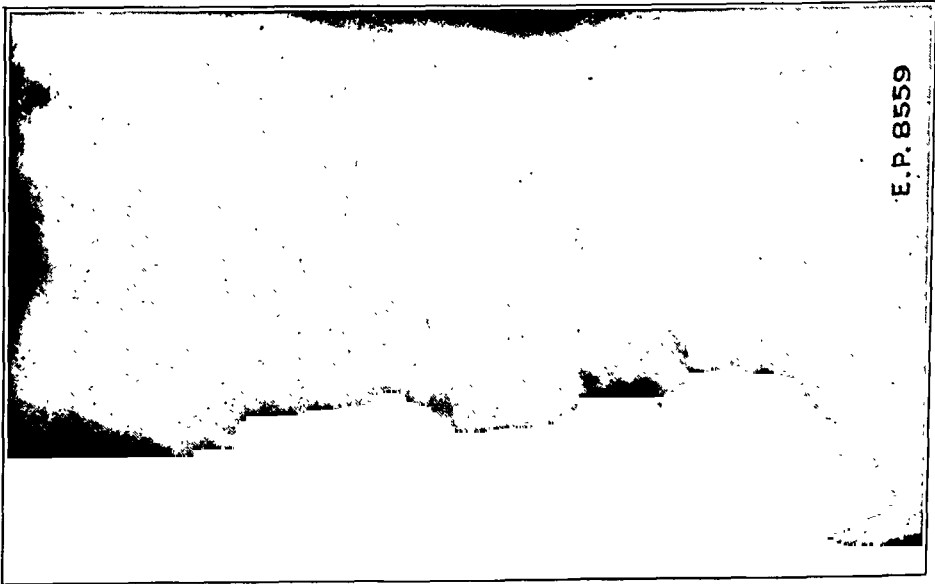


Fig. 1  
Lateral view of spine of Case 1 showing diminution of height of vertebral bodies and increase of intervertebral discs.



Fig. 2  
Anteroposterior view of Case 1.

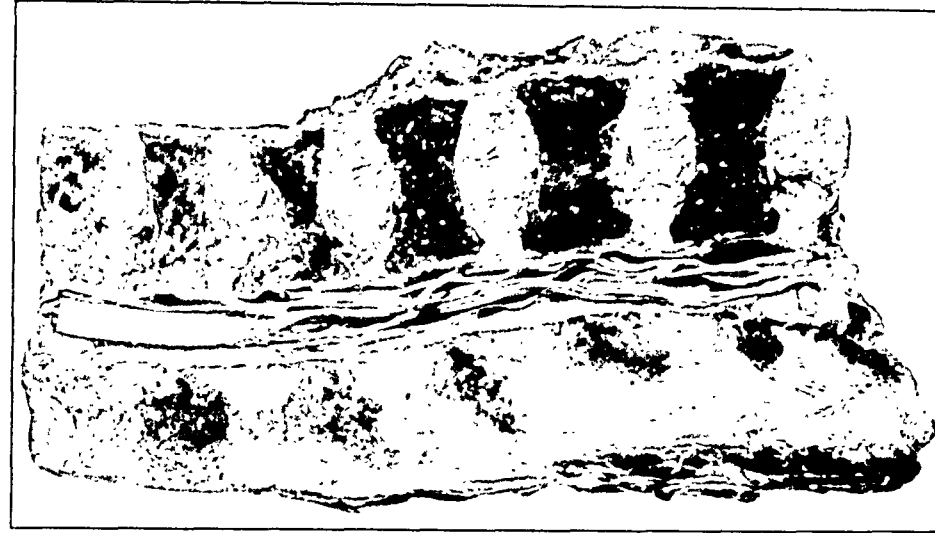


Fig. 3  
Photograph of section of spine shown in Figs. 1 and 2.

Blood chemistry findings (fasting) were as follows: sugar, 93.5 milligrams per 100 cubic centimeters; urea, 13.6 milligrams; uric acid, 215 milligrams; calcium, 7 milligrams.

The woman was re-admitted May 14, 1930. In the interval patient had been receiving parathyroid at the advice of a local physician. Examination at this time showed: Blood chemistry (fasting): sugar, 82.5 milligrams per 100 cubic centimeters; urea 11 milligrams; uric acid, 1.7 milligrams. Two hours after the injection of 100 grams of glucose, the sugar was 127 milligrams; four hours after, the sugar was 87.5 milligrams and the calcium 11.3 milligrams. The basal metabolism at this time was minus thirty per cent.

X-rays on this admission showed further decalcification of the body of the vertebra and increase in height in the intervertebral disc. Phosphorous and calcium balance are reproduced.

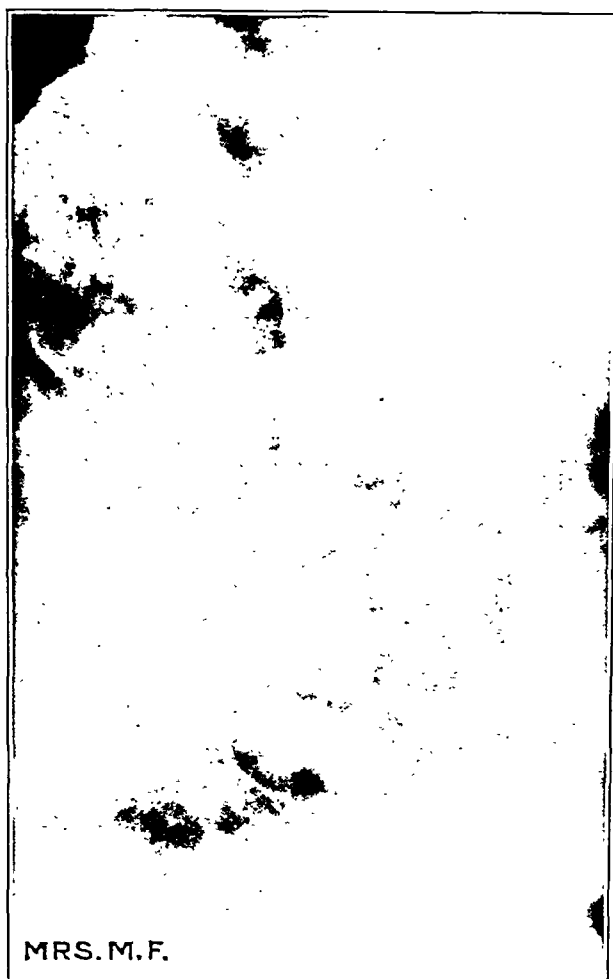


FIG. 4

Lateral view of spine of Case 2 showing fracture of a vertebral body.

## REPORT OF LABORATORY EXAMINATION

<i>Patient</i>	<i>Examination Made</i>	<i>Report Made</i>
Name, Case 3. Age 63	May 2 and 3, 1930.	May 15, 1930.
Examination Required: Calcium balance for 24 hours.		

*Result of Examination*

<b>Blood:</b>		<b>Excretion:</b>	
Calcium as Ca	10.8 mg. per 100 c. c.	Urine—	Volume 710 c. c.
Phosphorus as P	3.9 mg. per 100 c. c.		Sp. Gr. 1.010
Fibrin	0.4 per cent.		CaO 0.12 grams
Albumin (serum)	5.5 per cent.		P <sub>2</sub> O <sub>5</sub> 1.34 grams
Globulin (serum)	2.7 per cent.		MgO 0.16 grams
Total serum proteins	8.2 per cent.	Feces—	Weight 110 grams
			CaO 1.05 grams
<b>Intake in Food:</b>			P <sub>2</sub> O <sub>5</sub> 2.38 grams
Calcium as CaO	1.05 grams		MgO 0.48 grams
Phosphorus as P <sub>2</sub> O <sub>5</sub>	2.28 grams		Microscopically: No fat, no soap, some vegetable fiber.

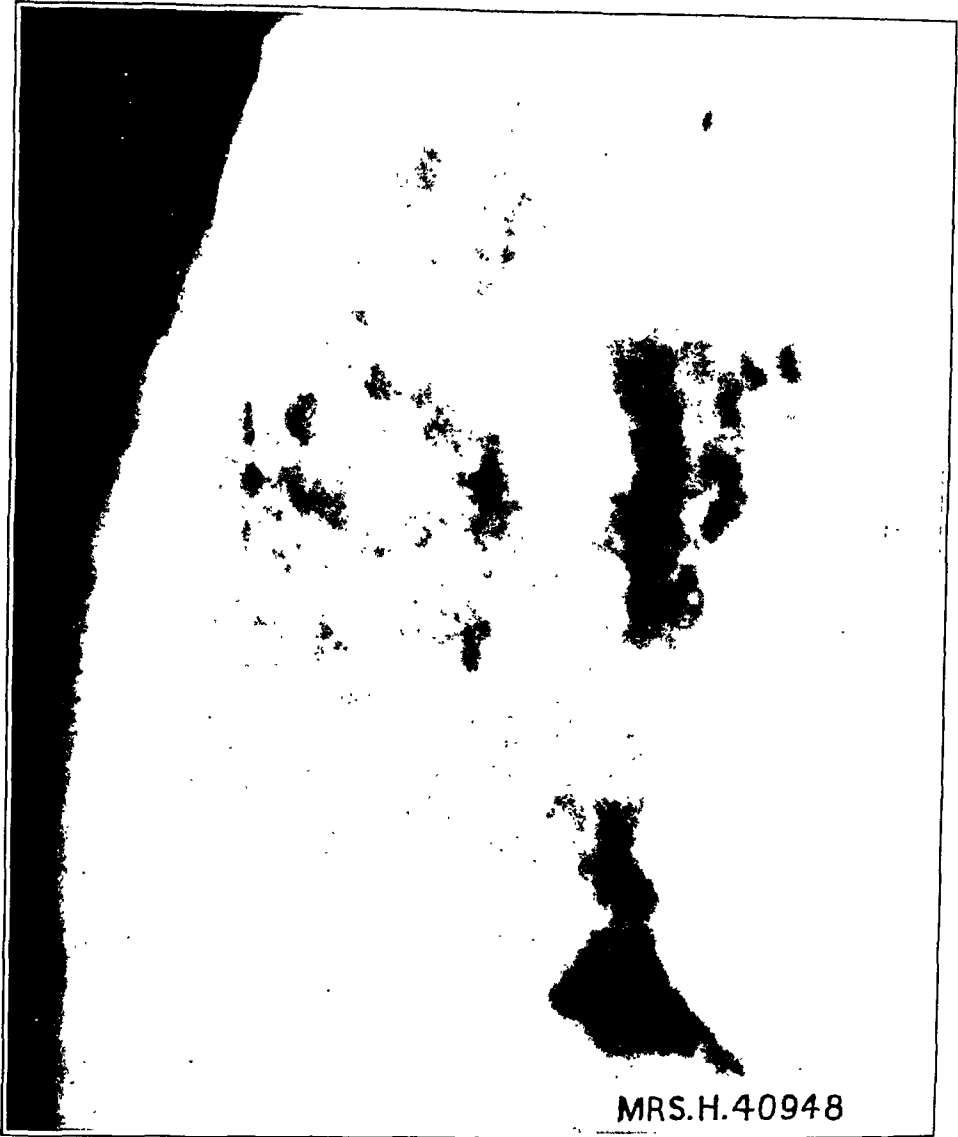


FIG. 5  
Lateral view of the dorsal spine of Case 3.

REPORT OF LABORATORY EXAMINATION (Continued)

Calcium Balance:

Intake in food	1.08 grams CaO
Output in feces	1.08 grams CaO
Output in urine	0.12 grams CaO

$$\text{Ratio} \frac{\text{CaO in urine}}{\text{CaO in feces}} = \frac{1}{9}$$

Balance            -0.12 grams CaO

Phosphorus Balance:

Intake in food	2.28 grams P <sub>2</sub> O <sub>5</sub>
Output in feces	2.38 grams P <sub>2</sub> O <sub>5</sub>
Output in urine	1.34 grams P <sub>2</sub> O <sub>5</sub>

$$\text{Ratio} \frac{\text{P}_2\text{O}_5 \text{ in urine}}{\text{P}_2\text{O}_5 \text{ in feces}} = \frac{1.0}{1.7}$$

Balance            -1.44 grams P<sub>2</sub>O<sub>5</sub>

Magnesium Excretion:

$$\text{Ratio} \frac{\text{MgO in urine}}{\text{MgO in feces}} = \frac{1}{3}$$

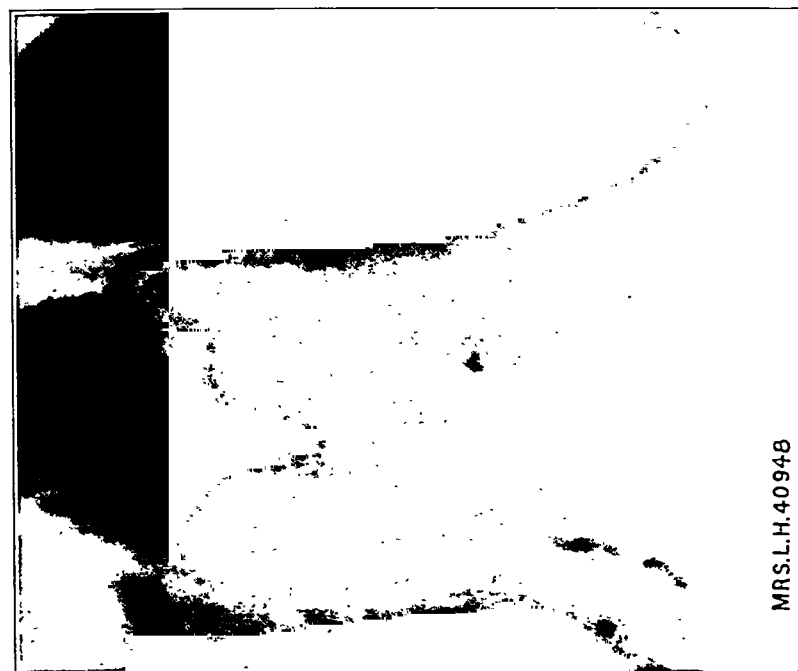


FIG. 6

Lateral view of the lumbar spine of Case 3 showing changes noted in text. The calcification is especially marked in this case.

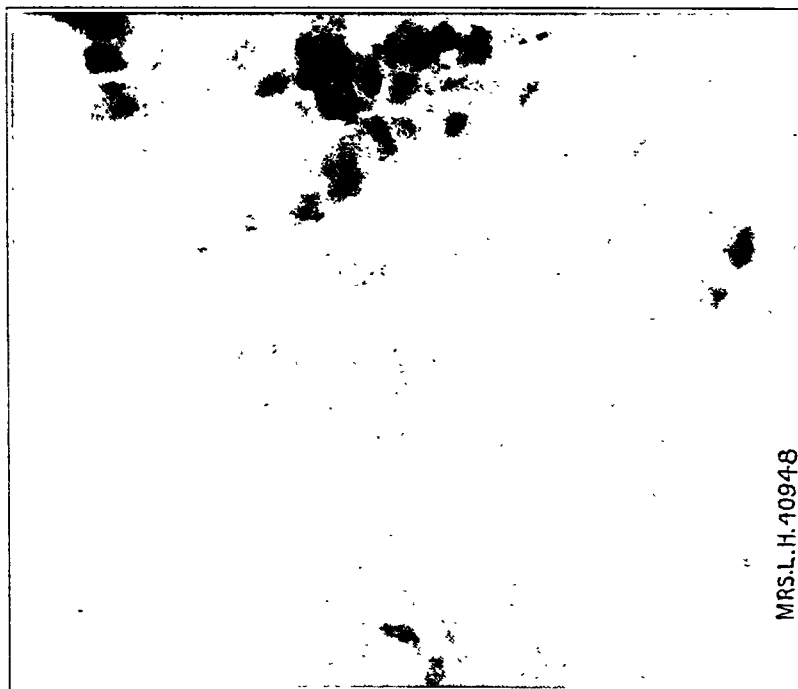


FIG. 7

Anteroposterior view of lumbar spine of Case 3.





FIG. 8

Lateral view of the dorsolumbar region of the spine of Case 4, showing compression fractures of the bodies of two vertebrae.

CASE 4. Female, aged sixty-one, complained of pain in the back, the result of a jar she received while riding over an uneven road, two years before. Roentgenograms of this patient are reproduced (Figs. 8 and 9).

CASE 5. Male, aged nineteen, complained of pain in the back with no history of trauma. The roentgenograms are reproduced (Figs. 10, 11, and 12).

*Physical examination:* Boy was typically of the pituitary dystrophic type. Spine was kyphotic about the twelfth dorsal vertebra. Sugar tolerance test confirmed the diagnosis of hypopituitarism. During his stay in the hospital, patient passed some blood in the urine which was unexplained by pyelogram and cystoscopy. Patient was given parathyroid and calcium lactate and discharged three small calculi. He was discharged from this hospital to the care of the writer at another hospital where his medication was continued. From this latter hospital he was dis-

charged to his home to remain in bed. However, on the second day after discharge, the patient decided to dress and died of acute dilatation of the heart. No autopsy was allowed.

The study of these cases was undertaken in an attempt to discover what had happened to the spine and why. The process seemed to be one of osteoporosis of the bodies with secondary changes in the intervertebral discs. Obviously, the body changes were due either to replacement of the normal bony tissue by malignant cells, or to decalcification. In Case 1 autopsy showed the first of these conditions to be present, but it was ruled out in the others. In these latter cases, where it was possible, a study was made to determine the cause of the loss of calcium from the vertebral body and in one, Case 3, the evidence would point to a faulty diet as the cause of the loss of calcium from the spinal column. In another, Case 5,

there was definite evidence of pituitary dysfunction.

The assumption of the spherical form by the disc has been attributed by Schmorl, who of the various observers has written most extensively of this condition, to expansion of the nucleus pulposus, due to release of pressure, the result of softening of the adjacent bodies. As the cause of this latter condition, Schmorl suggests chronic disease.

It would seem to the writer that there are several aspects which suggest that the process is one of compensatory hypertrophy, rather than release of pressure from an elastic nucleus.

First: The disc shown in Figure 11, which is almost globular, would

suggest an extraordinary degree of expansibility of this nucleus, were this the true cause of the enlargement. Moreover, as Schmorl has pointed out, this nucleus is seldom to be found centrally located in the disc, which would again make unlikely the assumption of so nearly spherical a form.

Second: In the sections shown by Sicard, Belot, Coste, and Gastaud, their Case 2 shows intact discs in spite of collapse of the adjacent vertebral body by metastatic cancer: whereas their Case 3 shows enlargement of the discs with invasion, also by metastatic cancer of the adjacent bodies.

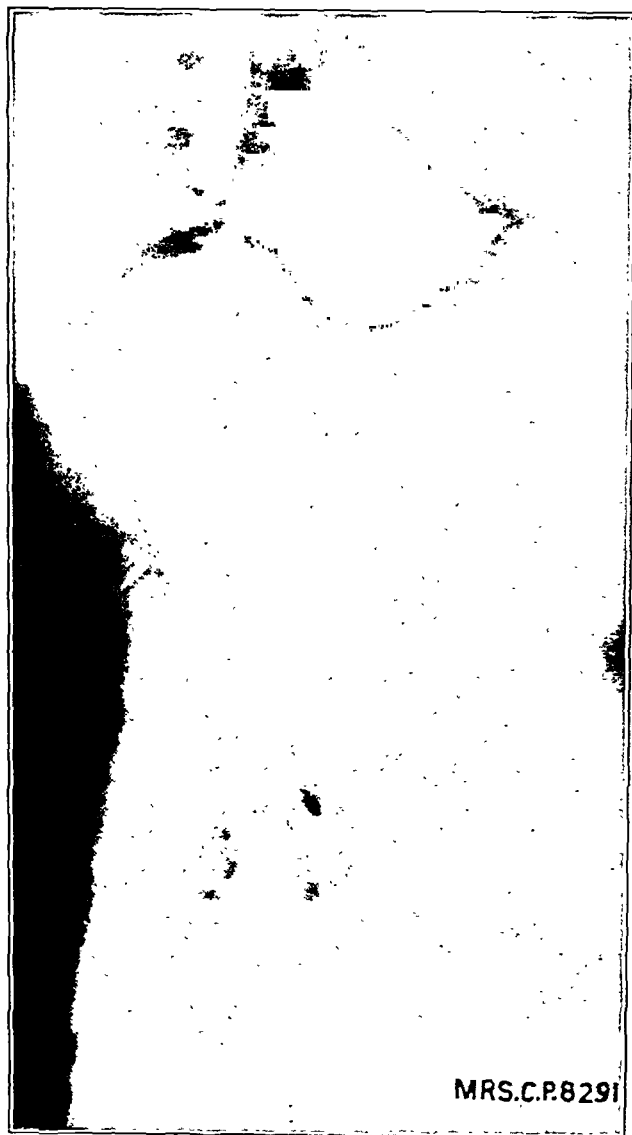


FIG. 9

Lateral view of the lumbar spine of Case 4 showing typical changes.

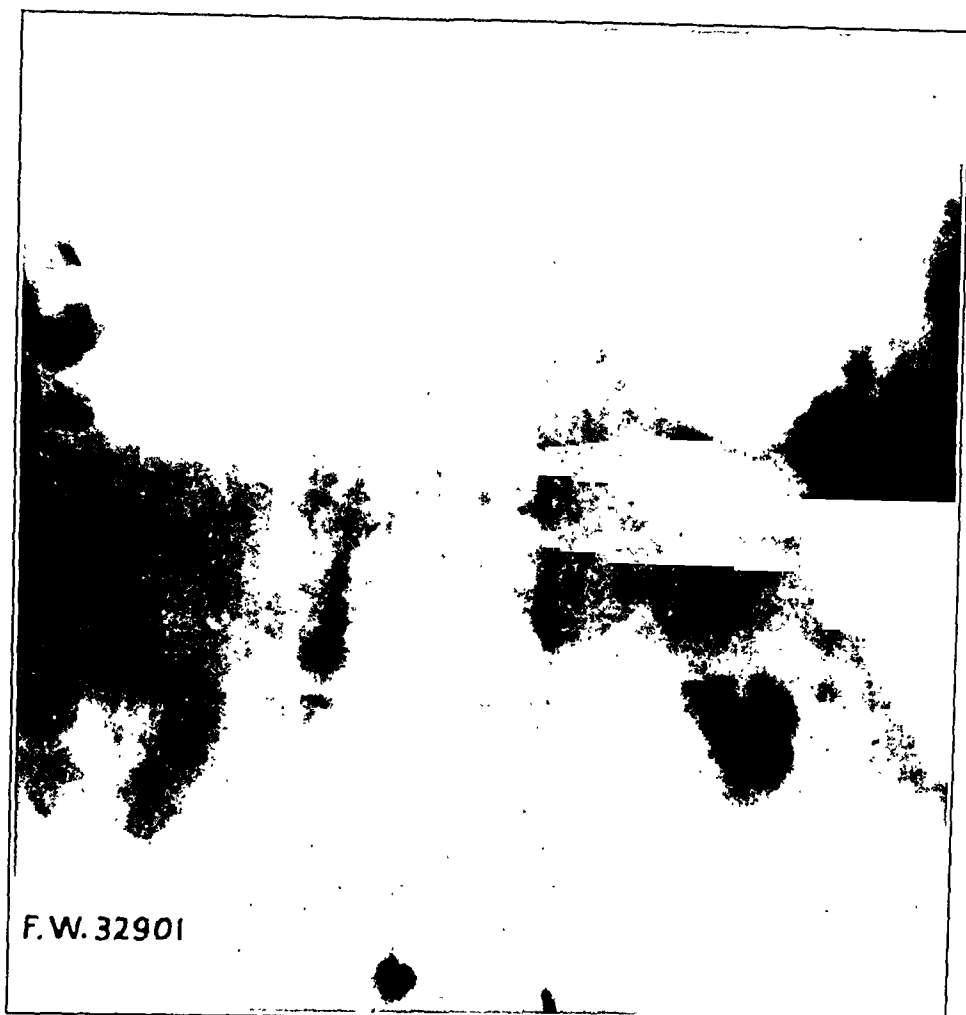


FIG. 10

Anteroposterior view of lumbar spine of Case 5.

In connection with these cases, it seems significant that their Case 3 showed evidence of metastasis to the spine fifteen months after onset of the primary tumor; whereas, in their Case 2, this period of time was two months,—that is, though there was a release of pressure in both cases by destruction of the vertebral body, in their Case 3 alone was the process so gradual as to admit of compensatory hypertrophy.

Third: The photomicrographs Figures 15 and 16 show evidence of the extension of the reparative processes healing the fracture of the cartilaginous layer to be from without inward, which would seem unlikely were there a force acting in a centrifugal direction, as implied by the theory of the elasticity of the nucleus. Weigert's elastic tissue stain failed to reveal elastic fibrils in either section.

Fourth: Photomicrographs (Figs. 18 and 19) show that there is an increased density of the tissue in the case of the pathological specimen as contrasted with the normal, with the occurrence of fibrocartilage.

Fifth: The calcium laid down in the spinal column in Case 5 (Fig. 11) under medication, was deposited exclusively in the discs. This would

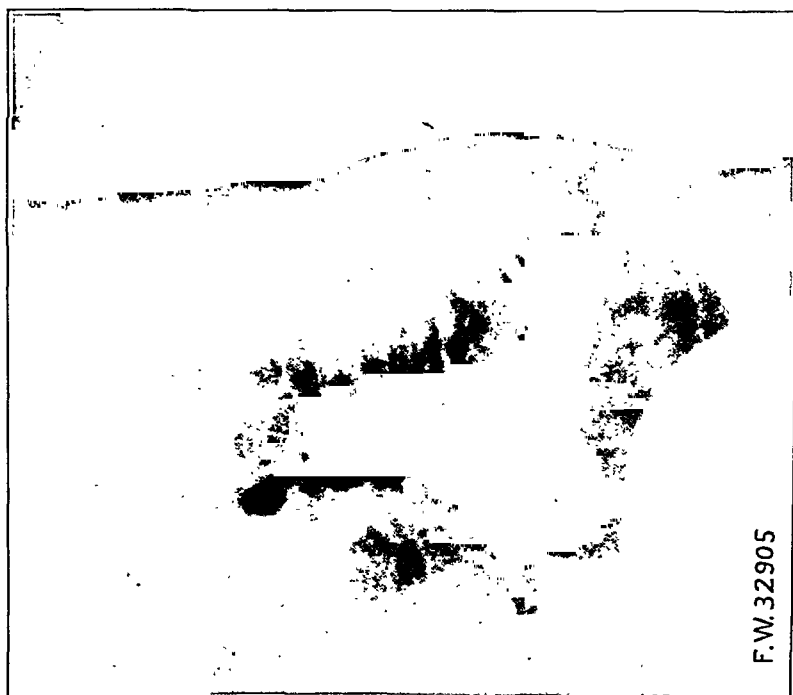


FIG. 12

Lateral view of the dorsolumbar region of Case 5, showing compression fractures of vertebral bodies.

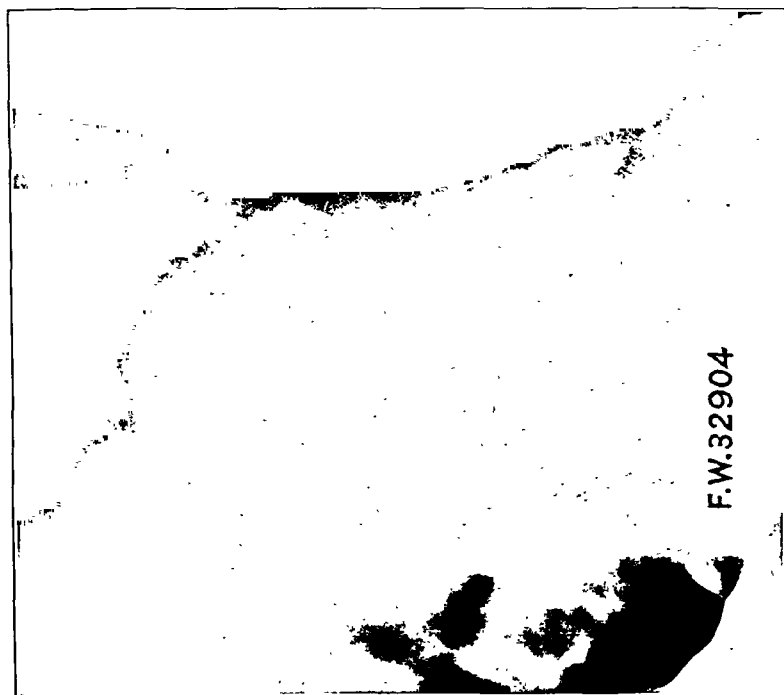


FIG. 11

Lateral view of the lumbar spine of Case 5 (taken after the administration of medication, showing calcification of the intervertebral discs and loss of the calcium content of the bodies.



FIG. 13

View showing structure of cartilaginous layer of normal disc.



FIG. 14

View similar to Fig. 13 in pathological specimen, showing hypertrophy and change of character of cartilage cells. The fibrous element of the disc shown beneath the cartilaginous layer is hyperplastic and much more compact than in the normal.



FIG. 15

Pathological specimen showing rupture of the cartilaginous layer with hemorrhage from without into the intervertebral disc. This represents the first stage of repair.

be more likely to occur in this type of tissue in a state of hyperplasia.

In conclusion, the writer believes that, whenever an increase in the height of the disc is encountered in an x-ray of the spine, it should be considered evidence of disturbance of some sort in the adjacent vertebral bodies and the character of this disturbance should be determined whenever possible to avoid further impairment of the integrity of the spinal column.

#### SUMMARY

Five cases of pathological fractures are outlined, in which the changes shown by x-ray were found to indicate the decalcification of the vertebral bodies and enlargement of the intervertebral discs:

This enlargement is believed to be due to a hypertrophy of the cellular elements of the discs, rather than to expansion of the nucleus pulposus.

The occurrence of these enlarged discs in an x-ray of a spine is indicative of impairment of the integrity of the spine.

Pathological fractures may occur in vertebral bodies without local disease, as the result of faulty metabolism.

Acknowledgment for invaluable aid is due Dr. John E. McWhorter of New York, pathologist, and Dr. William G. Herrman of Asbury Park, roentgenologist.

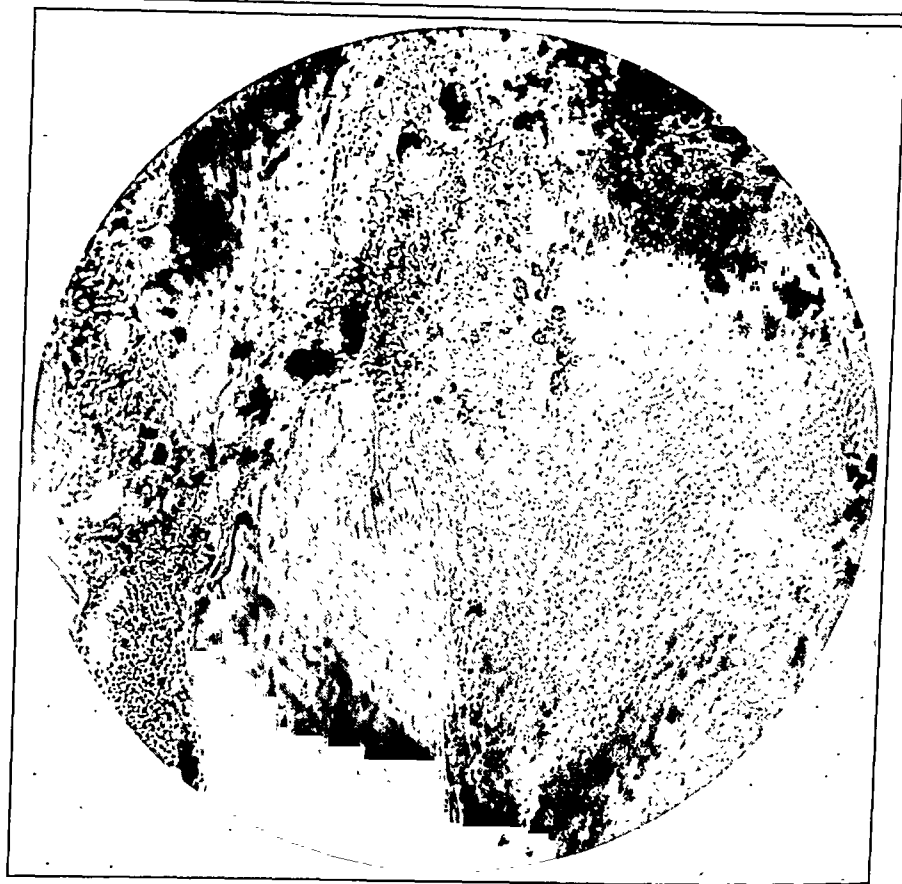


FIG. 16

Pathological specimen showing a more advanced stage of the reparative process with young granulation tissue.

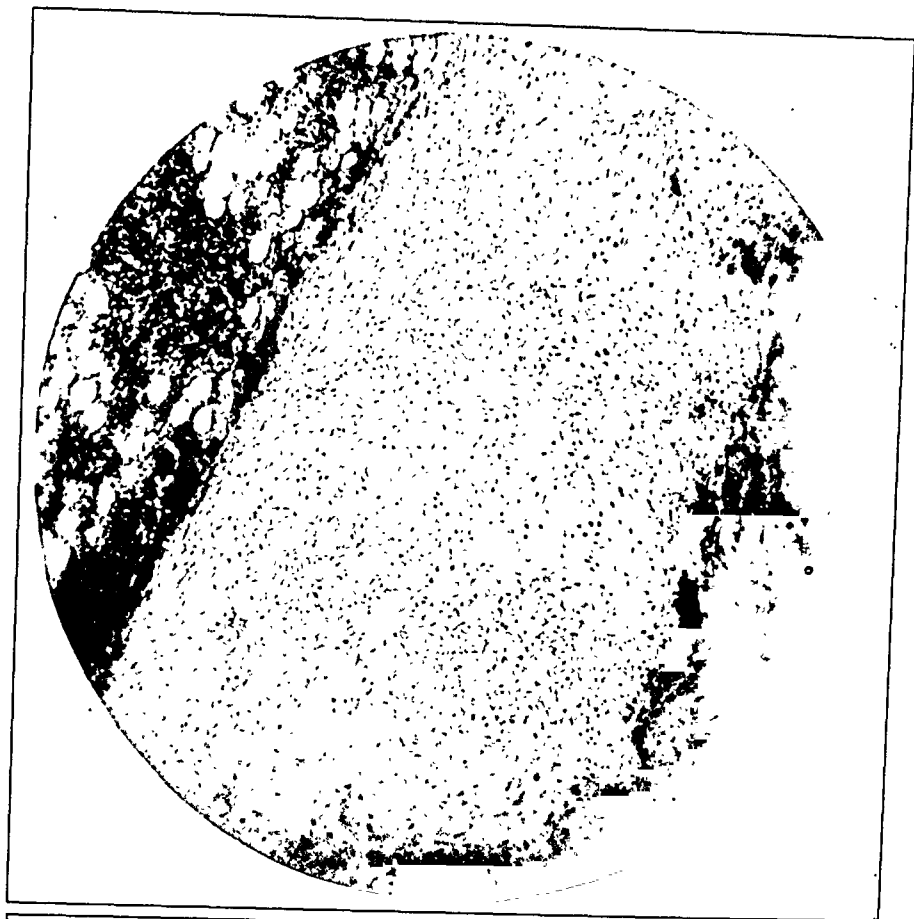


FIG. 17

Pathological specimen showing further stage of the reparative process with scar tissue and some fibrocartilage.

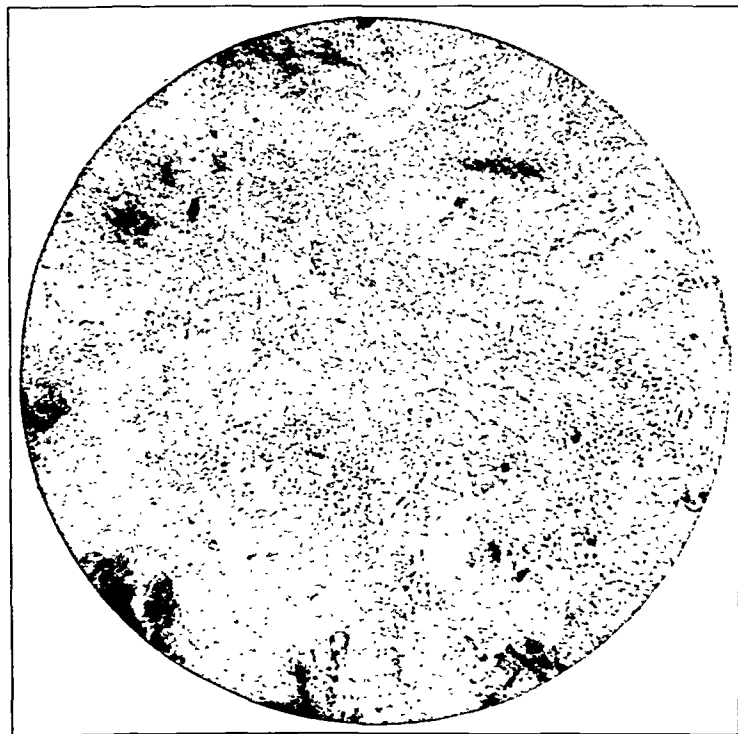


FIG. 18

Normal specimen. View showing structure of the interior of the disc. The fibrous tissue is not compact and contains many collagen fibers.

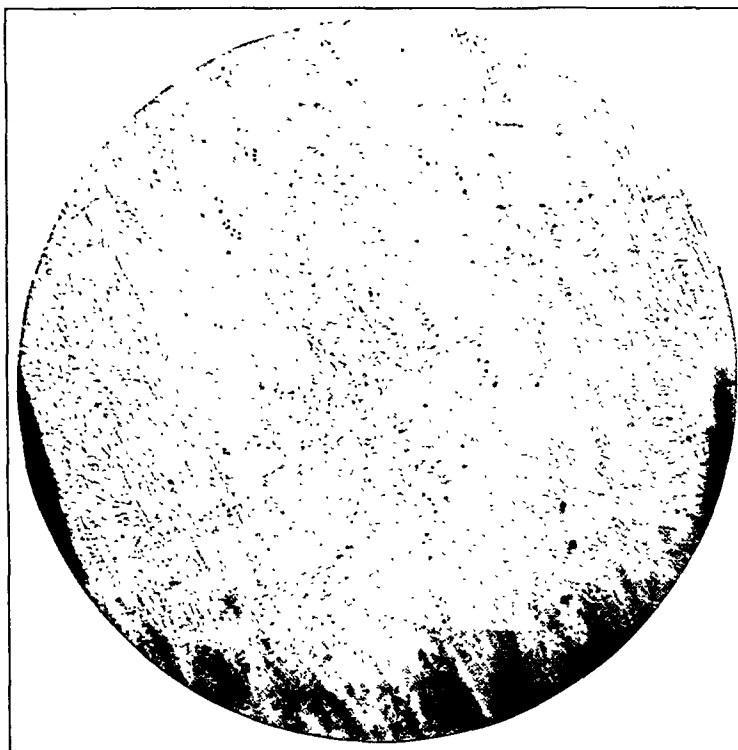


FIG. 19

Pathological specimen, view similar to Fig. 18, showing hyperplasia of fibrous tissue. The structure is much more compact and there are islands of fibrocartilage scattered throughout the section, indicating an attempt to strengthen the disc.



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# CYSTS OF THE INTERNAL SEMILUNAR CARTILAGE

BY PAUL C. COLONNA, M.D., NEW YORK, N. Y.

*From the Department of Orthopaedic Surgery, Bellerue Hospital, New York*

Cysts of the semilunar cartilages are rarely reported and a review of the literature has disclosed only ten cases involving the internal (Table I) and about fifty involving the external cartilage.

A study of the pathological reports of cases shows the wide divergence of opinion that exists regarding their mode of production. The old German view was that these cysts were comparable to ganglia and arose as the result of a degenerative process from deficient nutrition following trauma. Ollerenshaw believes the cysts are embryologic in origin, developing from the preexisting spaces in the cartilages, but in general most of the other observers are inclined to the view that they are related to ganglion formation, the method of their production being a mucoid or myxomatous degeneration.

In this condition there is usually a history of previous trauma to the knee joint, though at times it may be quite difficult to determine its exact relationship. The patient walks with a limp, complaining usually of no acute pain but of a dull ache in the joint. There is rarely a history of locking. The knee sometimes reveals very little on inspection. Frequently there is a well defined sensitive mass seen over the cartilage affected, which becomes more prominent when the knee is semiflexed, but in the case here reported no mass was visible. The extremes of motion are usually restricted. The roentgenograms rarely reveal anything of significance.

The following case is reported:

A student, male, twenty-two years of age, weighing 180 pounds, was first seen on August 5, 1932. Previous to five years ago he had had no trouble with the knee whatsoever, but at that time, while playing football, he wrenched his left knee. He had to be carried from the field, and, according to his description, presented a perfectly characteristic clinical picture of a torn left internal semilunar cartilage. Under rest and support the knee gradually improved and he was able to continue playing football after a few months.

For the next four years and a half the knee gave him no pain, although it felt "weaker and less secure" than the right. In June 1932, six weeks before he was seen by me, he injured the knee and had a recurrence of his old trouble. Since that time there had been a sense of increased insecurity about the joint and he had had many attacks of very definite locking. These had been relieved by forcibly extending the knee, but he had had attacks of pain and stiffness three or four times a day.

Examination showed a well developed male, walking with a slight limp and holding the left knee slightly flexed. The knee joint was not enlarged and there were no visible masses noted. There was no sensitiveness on pressure over either the internal or external semilunar cartilages and no increased fluid. The movements were normal except in the extremes of motion. He was admitted to the hospital for an exploratory operation, the need for this based mainly on the history of frequent locking.

The operation was performed on August 10, 1932. Under an Esmarch bandage and general anaesthesia, the left knee joint was opened, using the medial patella incision. On opening the joint, a slight increase in the joint fluid was noted. On reflecting the patella laterally, it was immediately seen that the internal semilunar cartilage had been previously torn and the posterior portion was distorted and frayed. The anterior two-thirds was enlarged and thickened. Several small cystic areas, the largest being about one-eighth of an inch in diameter, yellowish in color due to their fluid contents, were

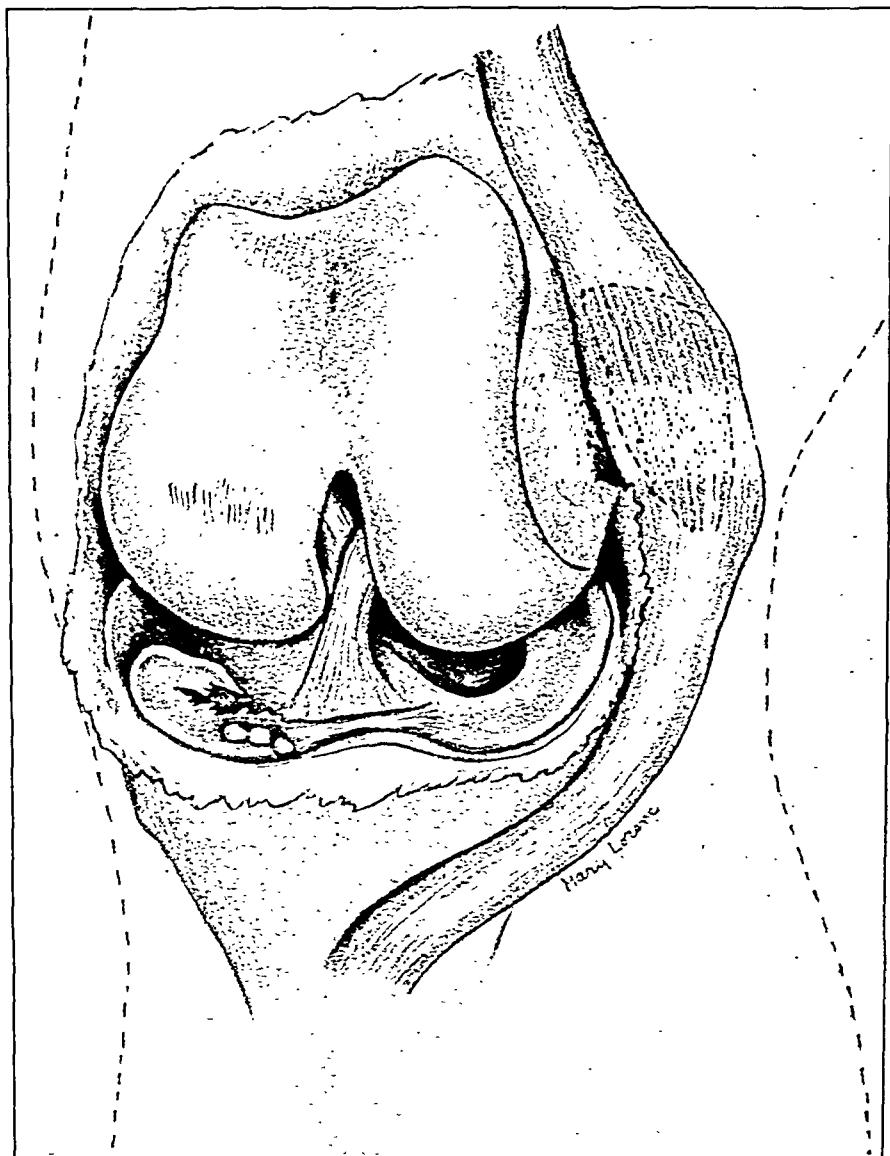


FIG. 1

Appearance of cartilages on opening joint. Note fibrillation of articulating surface of internal femoral condyle.

noted as shown in the drawing. There was a small area over the weight-bearing surface of the medial condyle of the femur which was fibrillated, but no definite erosion could be seen. The synovia was hypertrophied and purplish in color. The external cartilage appeared normal.

The internal cartilage was then completely removed. The wound was closed in layers and a pressure bandage applied from the groin to the ankle. The patient's convalescence was uneventful. At present he presents a full range of motion and has no pain on weight-bearing.

Through the courtesy of Dr. Douglas Symmers, Director, Division of Laboratories, Department of Hospitals, New York City, the pathological examination is here appended.

*"Macroscopic Examination:* The specimen consists of pearly white tissue measuring seven and five-tenths by three and seven-tenths centimeters. At one edge there are multilocular cysts, the contents of which are thin and watery.

*"Microscopic Examination* shows a groundwork of cartilage. The cartilage cells are irregularly scattered through the matrix, sometimes singly, at other times by twos and threes. The matrix itself is in places reticulated, in other places hyalinized, the hyalinization representing, apparently, direct transformation of the reticulated tissue. Numerous cyst-like formations are to be seen in the substance of the cartilage. The origin of this appears to take place in the following fashion: First, the cartilage breaks up into irregularly rounded or oval, isolated islands of hyalinized tissue, scattered through which only a few cartilage cells are to be made out. Various degrees of solution of cartilage can now be followed until the cartilage finally disappears entirely, leaving behind a cyst-like formation, the walls of which are composed of more or less well nucleated, reticular connective tissue which has arisen in an effort to wall off the autolyzing cartilage. In other words, the cysts or cyst-like formations come into being as a result of death of cartilage, the necrotic tissue acting as a foreign body which eventually is enclosed by connective tissue. The end result consists of complete solution and disappearance of the hyalinized and necrotic cartilage, leaving a cyst-like formation.

*"Histological Diagnosis:* Pseudocyst formation in fibrocartilage."

After the process of hyalinization has begun, the stages of cartilage death, liquefaction, and alteration of the connective-tissue cells into endothelial-like cells (lining these pseudocysts) by pressure from within are all logical sequences. We cannot agree with Fisher that these cysts are extracartilaginous in character or with Ollerenshaw that they are true endothelium with the power to secrete.

We believe they are degenerative in character, not arising from the lymphatics. The external cartilage is more firmly attached to the underlying tibial bone and is not, therefore, subject to the same degree of mobility during movement but, by its location on the outer side of the knee, is more frequently exposed to direct trauma. Whether this is a factor or not, the development of cysts in the external cartilage is much more frequently observed.

This is the eleventh reported case of cysts of the internal semilunar cartilage and here the picture was complicated by the case presenting an old torn semilunar cartilage, while in the anterior portion of the internal cartilage there were found definite multilocular cysts. These were located where they would necessarily receive very little of the trauma of weight-bearing and, except for the torn semilunar cartilage, the knee might not



FIG. 2

At left, two islands of hyalinized cartilage surrounded by and separated from one another by a layer of cellular connective tissue.

At right, pseudocyst formation, showing at the center an irregularly outlined remnant of hyalinized cartilage which is partly dissolved, and lined by a condensed layer of connective tissue.

Drawing made from slide with Edinger projection microscope ( $\times 100$ ).

have given evidence of their presence until they had increased in size. Certainly no clinical evidence of a tumor mass was noted. Therefore, this probably represents an early stage in this condition and would probably have been unrecognized except for the locking produced by the torn cartilage. The factor or factors that initiated the hyalinization of these cartilage cells remains a matter for speculation, though trauma cannot be overlooked. It is interesting in this connection to consider some experimental work done by McWhorter and his associates some years ago at Columbia University. They demonstrated that pseudocysts, presenting a cell wall of endothelial-like cells, could be experimentally produced by injecting into the subcutaneous tissues minute particles of sterile celloidin. These cysts resemble those found in the case here



TABLE I  
SUMMARY OF CASES OF CYSTS OF THE INTERNAL SEMILUNAR CARTILAGE  
PREVIOUSLY REPORTED

Author	Date	Number	Sex	Age	Remarks
Fisher . . . . .	1924	1 case	Male	27	Struck on inner side of knee by iron bar and definite lump noticed in six months.
Allison and O'Connor	1924	1 case	Male	22	No history of injury. Had noticed lump for three months.
Zadek and Jaffe . . . . .	1927	1 case	Male	39	Wrenched knee several months previously.
Bristow . . . . .	1928	2 cases	Male	69	No mention of injury. Aching pain in knee for four months.
			Male	55	No mention of injury. Lump noticed for six months.
Campbell and Mitchell	1929	1 case	Male	35	Painful knee five years. No history of injury.
Ollerenshaw . . . . .	1929	4 cases	Male	10	Injured knee one year previously.
			Male	6	No history of injury.
			Male	23	Previously hurt knee playing football.
			Male	33	No injury. Disability for four months.

reported and it seems more logical to consider the cystic formations to be initiated by trauma. The deficient nutrition to the affected portion may cause the cartilage cells to be transformed into islands of hyalinized tissue, which become liquefied, and through the process of pressure these cyst-like spaces become distended and the altered tissue filling the spaces acts as a foreign body. The connective tissue is thereby flattened into cells that resemble endothelial cells.

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# GIANT-CELL TUMOR OF THE SECOND CERVICAL VERTEBRA

## A CASE REPORT \*

BY MERRILL K. LINDSAY, M.D., F.A.C.S., NEW HAVEN, CONNECTICUT

*Associate Clinical Professor of Orthopaedic Surgery*

AND EDWARD H. CROSBY, M.D., NEW HAVEN, CONNECTICUT

*Instructor in Orthopaedic Surgery*

Giant-cell tumor of the long bones is relatively frequent, but the occurrence of such a benign tumor in the spinous process of the second cervical vertebra is unusual and, together with the age of the patient, makes the following case worthy of being recorded in the literature.

Dean Lewis<sup>1</sup> in 1924 reviewed the literature on giant-cell tumors of the vertebral column and found sixteen cases which, with the case reported by him, made the total seventeen. In his series the youngest was seven years of age and the oldest forty. The lesion occurred once in the cervical spine, six times in the dorsal spine, seven times in the lumbar spine, and once in the sacrum. The location was not mentioned in the remaining cases. Metastases were not found in any of these cases but recurrences were noted in two, four, and six years after operation. Ossification occurred in three of these growths. In none was an attempt at complete removal made, either because of the possibility of injuring the cord or because of the extension of the growth into inaccessible parts. Atoxyl, Coley's toxin, roentgen ray, and radium were used in treatment. Recovery after partial removal or no attempt at removal was noted in thirteen of the seventeen cases.

Geschickter and Copeland<sup>2</sup> in 1931, in their chapter on Benign Giant Cell Tumor, reviewed two hundred and fourteen cases of these tumors. None was found in the cervical spine and relatively few occurred in the dorsal and lumbar spine.

A. B. (A-17646), a six-year-old boy, of Irish birth, came to the New Haven Dispensary July 27, 1932, complaining of stiffness and swelling in the back of the neck. This swelling was first noticed two and one-half months previously as a symmetrical fullness which gradually increased in size. At the time of his examination, the boy held his head stiffly, slightly forward, but complained of no discomfort in the neck. He played with other boys normally and the stiffness of his neck in no way interfered with his activities. Past and family histories were without interest.

Physical examination showed a fairly well developed and well nourished boy in good health except for the local condition in his neck. The head was held forward with the neck flexed about twenty degrees and the lateral motion was limited to forty-five degrees to either side. The head could be fully flexed on the chest, but backward movement of the head on the neck was very markedly limited. Forceful attempts to move the head to the side and backward caused only slight discomfort. About two centimeters below the occipital protuberance and extending on either side of the mid-line was a sym-

\* From Yale University, Department of Surgery, New Haven, Connecticut.

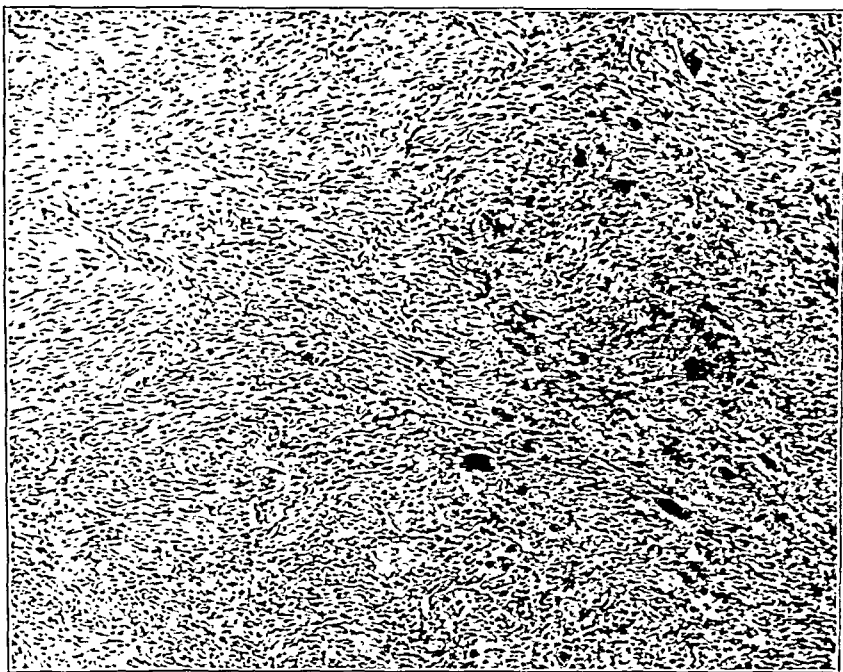


FIG. 2

Photomicrograph showing the typical arrangement of the fibrous connective tissue and the giant cells.



FIG. 1

Roentgenogram showing the giant-cell tumor of the second cervical vertebra.

metrical, hard, smooth swelling, the size of a tennis ball. This tumor was immovable and beneath the superficial muscles. When the head was flexed forward on the neck, no movement could be felt in the tumor which appeared to be closely associated with the spinous process of the second cervical vertebra. Pressure over this tumor caused no discomfort and no irregularities could be felt. Careful examination of the nose and throat revealed no swelling in the posterior pharynx, and in all other respects the physical examination showed normal findings. The blood and urine were normal.

A roentgenographic examination (Fig. 1) of the cervical spine revealed the vertebral bodies and the interspaces to be within normal limits. There was an expansile, cystic tumor involving the spinous and the transverse processes of the second cervical vertebra. The cortex was thin and coarse trabeculations were seen within this mass. The mass measured approximately four by four centimeters in the two greatest presenting diameters.

The patient was admitted to the New Haven Hospital on August 30, 1932, with a preoperative diagnosis of giant-cell tumor of the spinous process of the second cervical vertebra. Under ether anaesthesia, a mid-line incision was made, extending from the occipital protuberance to the fourth cervical spinous process. Dissection was made downward and the tumor mass was encountered about one centimeter beneath the skin. The shell of this tumor was very thin, friable, and the calcified layer was barely perceptible. Considerable hemorrhage was encountered when the tumor tissue was cut. Bleeding was controlled by hot wet packs. Inside the tumor shell multiple loculations filled with blood and soft, grayish, friable tissue were encountered. The trabeculations were broken down with the finger, and the contents removed, but no attempt was made to completely excise the tumor. The spinal cord could not be seen or felt, and it was believed advisable to remove only the soft tissue of the tumor. The patient was placed in a posterior plaster shell and the postoperative recovery was uneventful.

The specimen removed at operation consisted of two pieces of tissue, measuring twenty by twenty by twelve and twenty by ten by five millimeters respectively, and also some smaller fragments. The larger pieces were firm and had irregular, gray-white, and in places, hemorrhagic surfaces. The fragments consisted of hemorrhagic osseous debris.

Microscopic preparations (Fig. 2) show that the tumor consisted of neoplastic fibrous connective tissue with the cell nuclei and fibers arranged in stream lines and whorls. Giant cells are scattered throughout the microscopic fields in a rather uneven distribution. In occasional areas they are missing; in others, where small bony trabeculae are present, they are more numerous. In the margin a fragment of osseous tissue is seen. The marrow spaces of this are filled mostly with a loose fibrous connective tissue with an occasional giant cell.

The patient was kept in the posterior plaster shell for twenty-six days and then allowed to sit up with a Thomas collar to support the neck. He was discharged from the hospital October 15, 1932. At the time of discharge, the patient was able to hold his head erect without support, the tumor was slightly smaller than on admission, and motion backward and to the sides was greater. Roentgenographic examination showed no apparent change in the size of the tumor, but there was slight thickening of the cortex posteriorly and some osseous proliferation on the inferior portion of the tumor.

#### SUMMARY

A case of giant-cell tumor of the spinous process of the second cervical vertebra is reviewed. A roentgenogram of this tumor is presented (Fig. 1), and a photomicrograph (Fig. 2) showing the typical arrangement of the fibrous connective tissue and the giant cells is included.

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## TENDON AND MUSCLE RUPTURES

### CLINICAL AND EXPERIMENTAL STUDIES ON THE CAUSES AND LOCATION OF SUBCUTANEOUS RUPTURES

BY PAUL E. MCMASTER, M.D., CHICAGO, ILLINOIS

*From the Department of Surgery of the University of Chicago*

Following a report by the writer of late spontaneous ruptures of the extensor and flexor pollicis longus tendons subsequent to Colles' fracture, the subject of rupture of tendons has been further studied both clinically and experimentally. Results of these studies, including muscle rupture, are presented.

Subcutaneous tendon rupture occurs following direct and indirect types of trauma. Direct trauma, such as a tendon being caught between bone and traumatizing agent, may occasionally cause subcutaneous tendon rupture. The most common cause, however, is indirect violence, such as a forcefully contracting tendon subjected to a strong passive force in the opposite direction. Evidence will be produced to show that in this latter group true rupture of normal tendon does not occur.

Spontaneous tendon rupture, however, may follow moderate or frequently slight strain to a tendon previously weakened by disease, trauma, or possibly aseptic necrosis resulting from an obstruction to the blood supply.

Tendon rupture, either immediate or delayed, may follow severe direct external injuries to tendon substance. This division of tendon ruptures, also the direct severance of tendons by knives, glass, and similar articles, will not be stressed in this paper as these conditions do not give a true indication of the tensile strength of tendons.

However, in the indirect type of trauma the force is exerted along the entire muscle-tendon unit from origin to insertion and the strength of the different parts is put to test. It is with this division of the subject that this work is mostly concerned.

There are numerous clinical examples of "tendon rupture" following indirect trauma. One of the most frequent of these is the rupture at the insertion of the extensor tendons of the fingers into the base of the distal phalanges. This usually occurs following a forceful passive flexion of the distal phalanx, while the finger is being actively extended. It is not infrequently seen on the baseball field from a blow on the finger tip by a ball. The condition is often referred to as a "baseball finger" or "mallet finger". At the distal interphalangeal joint, capsule and extensor tendon are intimately associated. Hence, with this injury there is a separation of the tendon from its insertion and usually a capsular tear. Occasionally the tendon takes away a small fragment of periosteum and bone. There

is variance of opinion among surgeons as to the treatment of this condition. A number advise immediate operation with suture of the tendon to its point of insertion, followed by splinting in extension or hyperextension. Others, however, prefer conservative treatment and apply hyperextension splints immediately. This latter procedure has been the more successful one in the cases treated by the surgical staff of the University of Chicago Clinics. Hyperextension splinting is applied for four weeks. The end results in cases treated immediately by operation have often been discouraging. Stitches have either pulled out or infection has followed, and the deformity has sometimes recurred. In cases with the typical deformity, seen four weeks or longer after injury, operative repair is advisable, as otherwise the result will usually be unsatisfactory. In case the tendon heals in a lengthened condition, due to bridging the gap with regenerated tendon, a tendon shortening operation may be done.

Another tendon rupture occurring in the hands, although not frequently, is the rupture of the dorsal aponeurotic slip at the proximal interphalangeal joint. A brief review of the anatomy of the extensor tendons to the fingers will assist in an understanding of the mechanics concerned in these "button-hole" ruptures.

As the extensor tendons to the fingers reach the proximal phalanx, they spread out into three parts, a central tendon slip and two lateral slips. The central slip of tendon passes directly over the dorsal surface of this phalanx, becomes associated with the capsule of the proximal interphalangeal joint, and inserts into the base of the middle phalanx. The two lateral slips pass to either side of the interphalangeal joint, being loosely attached to the joint capsule, converge over the middle phalanx, and then insert into the capsule and base of the distal phalanx. Into these lateral slips of extensor tendons, the lumbrical and interosseus



FIG. 1

Photograph and roentgenogram showing the typical deformity of "button-hole" rupture. The proximal phalanx is extended, the middle phalanx is flexed, and the distal phalanx is hyperextended. The x-ray reveals a small fragment of bone almost completely detached from the base of the middle phalanx, at the insertion of the central tendon slip of the extensor tendon to the finger.

muscles are inserted. In the condition of "button-hole" rupture, the central dorsal slip ruptures and the two lateral slips, being loosened from their attachment about the joint, become displaced volarward. The volar displacement of these two tendon slips is further increased by the pull of the lumbrical and interosseus muscles. The cause of the injury is most commonly direct violence over the first interphalangeal joint; less commonly, as M. L. Mason<sup>1</sup> has pointed



FIG. 2

The third, fourth, and fifth fingers have "button-hole" ruptures of the extensor tendons. On active extension of these fingers the same relations between the three phalanges were maintained,—namely, extension of the proximal phalanx, marked flexion of the middle phalanx and hyperextension of the distal phalanx, as shown in this illustration. The condition in the fifth finger was less marked than in the other two although the deformity is present on extension of the finger.

out, the fingers are being actively extended when a blow or fall leads to forceful passive flexion of the finger. The rupture in these cases is usually at the insertion of the central tendon slip into the base of the middle phalanx. Figure 1 illustrates such a case.

This woman, aged thirty-seven, caught her right hand in a washing-machine wringer one month before coming to the University of Chicago Clinics. Following the injury the patient was unable to fully extend or flex the right third finger. Examination revealed considerable swelling about the proximal interphalangeal joint. On attempting to extend the finger, the typical deformity,—namely, hyperextension of the distal phalanx, flexion of the middle phalanx, and extension of the proximal phalanx, resulted. Roentgenograms showed a small bony fragment almost completely detached from the base of the middle phalanx at the point of insertion of the central tendon slip. Operative treatment was advised but has been refused. Subsequently operation was performed and the findings were similar to those described in the second case. The deformity has been improved and function is good.

A second case illustrating this condition was as follows:

A woman, aged twenty-seven, had had her right hand caught in a door jamb eighteen months prior to admission. Following the injury the right third, fourth, and fifth fingers became "drawn up" as she described it. On examination these three fingers exhibited the typical deformity of "button-hole" rupture, that of the fourth finger being the most marked (Fig. 2). Roentgenograms revealed no bone pathology of the proximal interphalangeal joints. Due to the long standing of this condition it was decided to operate upon one finger at a time. The fourth finger, being the worst, was chosen first. At operation the two lateral slips of tendon were found displaced volarward, the medial slip being displaced considerably more than the lateral. After freeing these slips from a number of adhesions and on attempting to straighten the finger, the flexor tendon was found to be preventing complete extension. However, after exerting considerable passive force, the finger was extended and it was then noted that the rupture of the central tendon slip had healed in a lengthened condition. This portion was shortened and the



two lateral slips were then sutured together with linen over the proximal interphalangeal joint. After closure the finger was placed in a hyperextension splint. Infection and sloughing out of sutures gave a poor result in this case.

Rupture of the supraspinatous tendon has been studied extensively by Codman and Akerson<sup>2,3</sup>. It is significant that this condition occurs practically always in middle-aged or older people. Hence as Codman says there may be changes in the integrity of the tendon due to age, constitutional conditions, or overuse. Wilson<sup>4</sup>, who has also studied this condition in a number of patients, states that the pathological observations at



FIG. 3

Bilateral rupture of the long head of the biceps brachii. The ruptures occurred within a few days of each other and followed only slight exertion. This patient had generalized hypertrophic arthritis.

operation indicate gradual weakening of the tendon previous to the occurrence of rupture. Doubtlessly repeated trauma, as forceful sudden abduction with the tendon caught between the greater tuberosity and the acromion process, accounts for damage to this tendon. Following such an in-

jury the fairly common sequel of calcification may result, and, subsequent to this condition, rupture could occur. Codman further states that the rupture may be the result of the same phenomenon which is known as arthritis in other joints. He also considers attrition of the tendon as an etiological factor to this rupture.

In considering rupture of the long head of the biceps brachii, there is considerable doubt if this occurs in the tendon substance without some preexisting disease which weakens it. Meyer<sup>5,6</sup> has made numerous anatomical studies of shoulders and has a number of times found the tendon of the long head of the biceps destroyed. The destruction with rupture occurs in the region between the humeral tuberosities and the supraglenoid tubercle of the scapula. From his studies he postulates that the destruction of the tendon is due to an occupational trauma and considers abduction and external rotation the motions responsible. Hence his explanation for this rupture is on a basis of friction. Cotton<sup>7</sup> states that rupture of the long head of the biceps is due to fraying of the tendons as a result of an occupational arthritis. Gilcreest<sup>8</sup> believes that senility, with degenerative changes, or disease are important etiological factors. Steinmann<sup>9</sup> reviewed this subject, including the report of the German industrial surgeons in 1931. He states that rupture of the long head of the biceps brachii is a result of chronic damage to the tendon.

Figure 3 shows a patient with bilateral rupture of the long head of the biceps brachii.

This patient, sixty-five years old, had a generalized chronic arthritis. The ruptures occurred within a short time of each other and both followed only slight muscular exertion. These ruptures probably occurred as a result of fraying of the tendons from arthritic changes in the shoulder joints. The condition resulted in but slight weakness and discomfort and was left untreated.

Gilcreest <sup>8</sup> reports an interesting case of avulsion of the long head of the biceps from its origin, including a portion of the cartilage of the glenoid attachment, following an indirect type of violence. Hence, in this case with the tendon normal, separation occurred at the origin and not in tendon fibers. Gilcreest quoted Dr. Wilson Davidson as telling of a baseball pitcher who, on releasing a ball, felt a "snap" in his arm. On examination there was found a rupture of the triceps at the junction of the muscle and tendon rather than in the tendon itself.

A case reported by Schmieden <sup>10</sup> and another by Kerschner <sup>11</sup> further demonstrate the strength of tendon substance. In each there was detachment of the biceps tendon from the radial tuberosity. Here again the tendon itself did not rupture but the insertion gave way. Schmieden stressed the fact that rupture of the long head of the biceps follows a pathological change in the tendon fibers.

Another spontaneous tendon rupture encountered in the upper extremity occurs in the extensor pollicis longus and in all of these cases there is a preexisting tendon disease or injury. The most common cause of this rupture is a chronic tenosynovitis, occurring in drummers and first described by the Germans as "*Trommlerlähmung*", or drummers' paralysis. The condition occurs in other occupations also, such as tailoring, carpentering, and cane-making. The tenosynovitis occurs at the distal border of the radial groove, where the tendon runs obliquely lateralward around the bony ridge of the radial groove. Degenerative changes occur, consisting of swelling, inflammation, and aseptic necrosis. These may lead to tendon rupture following some exertion.

Rupture of this tendon also occurs as a late spontaneous sequel of Colles' fracture. It is due either to a partial tendon severance by a sharp bony fragment at the time of fracture, with insufficient healing and subsequent rupture at the weakened point following exertion (occasionally only slight), or to a local tendon necrosis resulting from injury to its blood supply at the time of fracture. The added pressure of the hematoma or later the callus may further obstruct the blood supply. A similar case has also been reported of late spontaneous rupture of the flexor pollicis longus tendon following Colles' fracture (McMaster <sup>12</sup>).

Tendon ruptures in the lower extremity are not infrequently encountered,—*e.g.*, in the Achilles tendon, quadriceps tendon, ligamentum patellae, and adductor tendons of the thigh. A rare tendon lesion which would predispose to rupture was reported by Meyer <sup>13</sup> who found in a cadaver a marked fraying of the peroneus brevis at the point of the calcaneofibular ligament.

Rupture of the Achilles tendon occurs, but it is problematical if it takes place in normal tendon substance. Quénu and Stoïanovitch <sup>14</sup> in 1929 reported two cases and collected sixty-eight others from the literature. They stated the condition to be rare, not encountered in the young or old, and most common between the ages of thirty and fifty. It was especially common in large and fat people, although occasionally found in those of athletic build. The authors explained these ruptures on the basis of some particular weakness of the tendon and considered syphilis important. In reviewing the cases from the literature, they found that the majority occurred in syphilitics and a number demonstrated the presence of gummatous invasion in the ruptured tendons. The presence of such a condition explained why some of the tendons ruptured from only slight force. König <sup>15</sup> stated that these ruptures are usually associated with some disease,—as peritendinitis, lues, typhus, scarlet fever, and tabes. König also records a bilateral rupture of both Achilles tendons in a young adult male who sometime previously had been an athlete, but, because of a bad heart lesion, was then having very little exercise. Following a sudden strain, both Achilles tendons separated. Associated with these ruptures there was also a bilateral tearing out of a small bony fragment from each tendon insertion.\*

True rupture of the ligamentum patellae and quadriceps femoris tendons occurs rarely if ever. Most often, following indirect trauma, either the patella fractures or the insertions of these tendons to it give way (Hugel <sup>16</sup>), or the quadriceps tendon pulls away from its muscle junction. In not a few cases there is a small fragment of bone pulled away, especially with rupture of the quadriceps femoris tendon (R. L. Mason <sup>17</sup>). Gallie and Le Mesurier <sup>18</sup> described a number of cases of the above nature, including fractured patellae, but reported no cases of separation in the tendon substance itself. Wagner <sup>19</sup> reported a complete rupture of the infrapatellar tendon and adjacent capsular ligaments, which, although not clearly stated, apparently was a tearing out of the tendon at its insertion. R. L. Mason <sup>20</sup> has described a case of complete avulsion of the tibial tubercle and, according to him, Wilson found only two such cases in a review of the records of the Massachusetts General Hospital Fracture Service. Partial separation of the tibial tubercle, sometimes seen in Osgood-Schlatter's disease, is not infrequent.

Cotton <sup>7</sup> mentions the rare possibility of ruptures through the patellar ligament and through the quadriceps tendon. In a review of the available literature, I have not found a case that I think should come under this classification.

Fracture of the anterior superior spine of the ilium has been reviewed by Christopher <sup>21</sup>. In this condition, which practically always occurs before the epiphyses are closed, a small fragment of bone is detached from

\*Since this paper was written the author has encountered two cases of rupture of the Achilles tendon at the University of Chicago Clinics. One was at the insertion and pulled away a bony fragment; the other occurred at the musculotendinous junction.

the anterior superior spine of the ilium, by indirect violence of the tensor fasciae latae and sartorius muscles. A more appropriate designation, instead of fracture, is avulsion of the anterior superior spine. Rupture does not occur in the tendinous portions, but a small bony tag is pulled away from the origin, indicating a greater weakness of bone.

Davidson<sup>22</sup> reported two interesting cases of rupture of the adductor longus and adductor brevis muscles. Both of these had pulled out at their insertions in the femur and not in tendinous substance.

Among other pathological conditions predisposing to tendon rupture are tuberculous tenosynovitis (Kanel<sup>23</sup>) and gonorrhoeal tenovaginitis (Melchior<sup>24</sup>). A number of the former cases are found in the literature, but only one case of the latter, that reported by Melchior.

Destruction of tendon by tuberculosis is illustrated in the following case:

White male, aged twenty, had an arthrodesis for tuberculosis of the left ankle, one year previous to his second admission to the Clinics. At this admission a painful right shoulder was diagnosed as tuberculous arthritis. At operation for arthrodesis of the shoulder, extensive tuberculosis of the glenoid and head of the humerus was found. The intra-articular portion of the long head of the biceps was completely destroyed. The tendon and its sheath in the bicipital groove were extensively involved, the sheath having ruptured about two inches below the tubercles anteriorly, with caseating granulation tissue extending into the surrounding soft parts. Arthrodesis of the shoulder by bone transplantation was done. The long head of the biceps was excised down to healthy tendon which was then sutured to the short head. A cast was worn for four months. Six months after operation the shoulder was solidly fused and the biceps, although small, functioned as a whole.

Suppurative tenosynovitis frequently destroys tendons; however it rarely leaves a damaged tendon that subsequently ruptures.

#### MUSCLE RUPTURE

Rupture of muscle, either complete or incomplete, is a fairly frequent occurrence. It may be by direct or indirect violence, and occur either in normal or diseased muscle.

Undoubtedly if many of the aching and painful muscles, resulting from trauma, either direct or indirect, could be examined anatomically, a considerable number of partial muscle ruptures would be found, which are often overlooked or wrongly diagnosed as sprains, hematmata, myositis, neuralgia, etc.

The following four cases are examples:

CASE 1. Large obese female of thirty-nine, while running, caught her foot in a carpet and a few steps later fell because of severe pain in the calf of the left leg. The pain at first extended from her heel to the knee, but soon localized in the mid-calf region. Examination showed extreme tenderness over the mid-point of the left gastrocnemius muscle and the patient was unable to bear weight upon the foot. There was slight swelling, no discoloration of the skin and no muscle defect could be found. A diagnosis of partial rupture of the muscle belly of the gastrocnemius was made. Treatment consisted of an elastic bandage to the leg, and rest. After approximately three weeks all pain disappeared and full painless motion was present.

CASE 2. Well developed male of forty-eight, while pushing a heavy cart with an 1800-pound load, received a sudden unexpected strain on his arms. He felt something "give way" in the right neck and shoulder region with resultant pain. Disability was only slight, but pain persisted. Examination was essentially negative, except for pain to palpation in the muscle belly of the right trapezius. Swelling and discoloration were not present. Active and passive motions of the shoulder caused very slight pain. Diagnosis of partial rupture of the right trapezius muscle was made. After treatment for two weeks with the shoulder immobilized in a sling combined with heat and massage, the patient had completely recovered.

CASE 3. White male, aged thirty, received a severe direct injury from a heavy iron pulley to the right forearm twelve months before admission to the Clinic. A few days prior to his admission he attempted, for the first time after the accident, to do heavy lifting. He suddenly experienced great pain at the point of his previous injury. Swelling, discoloration, and weakness resulted. At operation a nearly complete fresh rupture of the flexor carpi radialis muscle was found. At the site of rupture there was considerable scar tissue, indicating a partial muscle belly rupture following the original direct injury.

CASE 4. Two powerful men, sitting opposite each other, rested right elbows on a narrow table, with the forearms upright, grasped hands, and each attempted to bend the other's forearm down to the table. After twenty minutes with neither succeeding, one suddenly developed a severe pain in the belly of the biceps muscle. This was followed by considerable swelling and some discoloration. Severe pain to palpation was present in the muscle belly. No defect was palpable, due to the swelling. Some biceps motion was present, but definitely limited. This case illustrates muscle belly rupture from severe indirect violence.

Muscles rupture in the contracted state when incurred by indirect violence. Lexer<sup>25</sup> states that a muscle may be ruptured in the resting state by indirect violence, but this seems very unlikely, at least in normal muscle.



FIG. 4

Almost complete rupture of the rectus femoris muscle belly by direct violence. The mass shown above the depression in the mid-thigh on the anterior surface was easily seen when the quadriceps femoris was contracted.

Direct injuries may also cause muscle rupture, but, according to Lexer, this is rare when compared to indirect violence with rupture of the contracted muscle. Montgomery<sup>26</sup> reported a case of ruptured triceps muscle belly, following a severe direct blow on the muscle.

The following case illustrates muscle rupture from direct injury:

Male, aged thirty-two, received a direct blow on the left thigh and ankle with a heavy piece of steel three months before admission to the Clinics. A fractured left ankle had been treated by a cast for eight weeks. Considerable swelling and soreness occurred in the left thigh immediately following the injury. This gradually subsided, except for slight weakness and a noticeable painless mass on the anterior surface of the lower third of the thigh. The mass stood out prominently when the leg was extended (Fig. 4). At operation a nearly complete rupture of the left rectus femoris muscle at its junction with the quadriceps tendon was found. The muscle was pulled down and sutured in its normal position. Contour and function were restored to normal.

Another patient, female, aged twenty-two, was operated on in the Clinics for almost complete rupture of the rectus femoris muscle belly, following direct trauma from an auto accident (Fig. 5). Nearly normal function and appearance have returned.

Disease processes may be etiological factors in muscle rupture. During the "flu" epidemic in 1918-1919, Abrahams *et al.*<sup>27</sup> saw over twenty cases of ruptured rectus abdominis muscles associated with pneumococcal and streptococcal influenzal septicaemia. The location was below the level of the umbilicus. The muscles examined at autopsy by these authors showed a definite relationship to Zenker's degeneration, such as occurs in other infectious maladies, except that these muscles were hemorrhagic and not pallid.

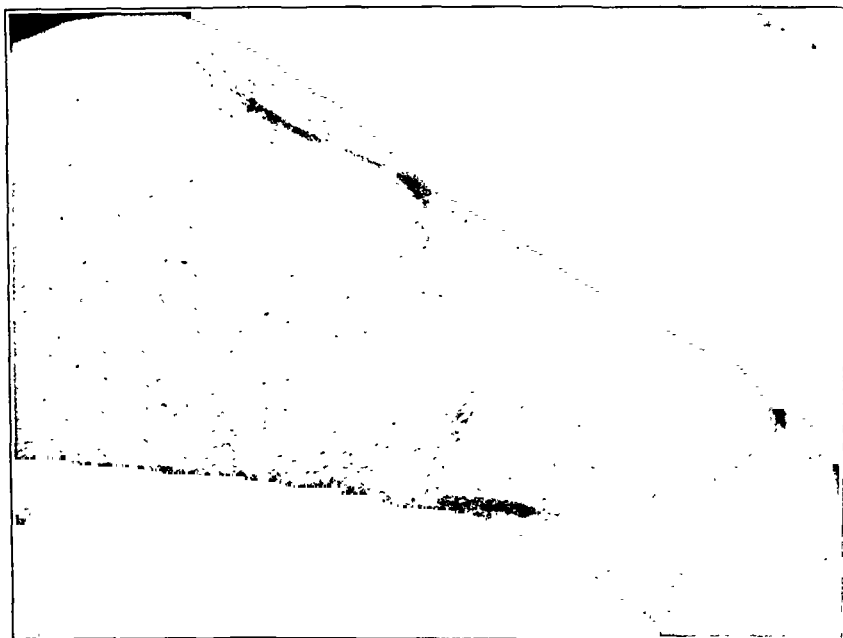


FIG. 5

Almost complete rupture of the rectus femoris muscle belly from direct trauma.

TABLE I  
RUPTURES IN NORMAL GASTROCNEMIUS TENDON-MUSCLE-BONE PREPARATION

	<i>Approximate Weight Producing Rupture (kilograms)</i>	<i>Location of Separation</i>
1	23	At insertion and with small bony fragment from os calcis
2	17	From medial femoral origin with bony tag
3	20.5	Femur fractured through point of drill hole
4	18.4	Same as 3
5	16	Same as 1
6	21.2	Musculotendinous junction
7	20	Both femoral origins with small bony tags
8	16	Insertion with bony cap attached
9	10.4	In muscle belly

Culbertson <sup>28</sup> and Perman <sup>29</sup> have reported rupture of the rectus abdominis during pregnancy and called attention to the susceptibility of this muscle, weakened by pregnancy, to subsequent spontaneous rupture.

Gilcreest <sup>8</sup> thinks that muscles rupture following certain occupational efforts,—*e.g.*, rupture of neck muscles occurring in load carriers and packers; of the biceps and triceps in pitchers and lifters; of the adductors of the thigh in horseback riders; of the calf muscles in boxers, tennis players, runners, and mountain climbers; and of the back muscles in stevedores.

Other pathological conditions of muscles which may lead to rupture are tuberculosis, syphilis, tumors, trichiniasis, typhoid, and general infections. Tetanic convulsions may also cause muscle rupture.

#### EXPERIMENTAL WORK

In order to determine the tensile strength of tendon fibers and the points of rupture, a series of experiments was done. These included tests on normal tendons, crushed tendons, tendons partly severed, tendons completely severed and sutured, and tendons ligated in an effort to obstruct the blood supply and produce aseptic necrosis. Young, healthy adult rabbits were used, and aseptic technique was employed where operative procedures were done.

In all experiments the rabbits were sacrificed and immediately the following procedure was carried out. The skin was dissected free from the leg which was then amputated through the upper thigh. The os calcis was separated from adjacent bones, with the Achilles tendon attached, and the gastrocnemius muscle more or less freed from surrounding tissues and left attached to the femur. A small drill hole was then made through the lower portion of the femur and a strong wire passed through. This was suspended from an overhead beam. Then to the os calcis was attached another wire from which hung a bucket and into this sand was added for weight (Fig. 6a).

In some of the experiments the sand was slowly poured into the bucket giving a gradually increasing weight until separation occurred.

In others a sufficiently heavy load to produce rupture was suddenly added. As to the type or location of the rupture, no difference was noted in the two procedures.

#### EXPERIMENTAL RESULTS

Nine normal preparations were used to determine the point or different points of rupture in tendons not previously diseased or injured. The exact amount of weight to produce these separations was not accurately determined, but approximate weights are included (Table I).

Ascertaining from these experiments that normal tendon did not rupture, tests were made to determine how much injury the tendon of such a preparation must sustain before it would break.

The same procedure as outlined above was carried out on tendons cut one-fourth through, just prior to testing with the weight. In three experiments the tendon did not rupture at the injured point. One separation occurred in the muscle belly, another at the periosteal insertion, and in the third the femur fractured.

Three tendons were then cut one-half through, just prior to adding the weight. All three ruptured at the point of partial severance.

Two tendons were severely traumatized by crushing with a Kocher hemostat and then tested. Rupture did not occur in either case at the crushed portion but occurred once in the muscle belly and once at the insertion.

A study of the effects of severe injury to tendon substance after allowing time for either tendon repair or necrosis was done as follows: Through a small incision the tendon was exposed, the sheath retracted, and the tendon traumatized by crushing with a Kocher hemostat and by pounding until fraying at this point resulted. The sheath was carefully replaced and sutured and the skin closed. In two experiments tested two weeks later, rupture occurred in the muscle belly instead of in the injured portions. Five weeks after the same procedure, two tendons were tested and rupture occurred once in the muscle belly and once at the insertion, pulling off a small bony tag.

The same procedure as above was then done, excepting that a cuff of

TABLE II

EFFECT OF DOUBLY LIGATING ONE CENTIMETER OF THE TENDON AND SHEATH

	<i>Time After Operation (days)</i>	<i>Weight (kilograms)</i>	<i>Location of Separation</i>
1	10	14.8	Periosteal insertion
2	10	13.2	Femur fractured
3	14	15.4	Muscle belly
4	14	16.2	Muscle belly
5	21	22.4	Muscle belly
6	21	21.2	Muscle belly
7	35	13.2	Origin with bony fragments
8	35	10.2	Ligated portion
9	35	9.8	Ligated portion



tendon sheath, two and five-tenths centimeters long, was removed around the severely traumatized portion. Two such preparations, tested five weeks later, separated at their origin and in the muscle belly respectively. Two other tendons, including sheath tissues, were crushed and severely pounded. When tested five weeks later, rupture occurred both times in the muscle belly.

The effect on the tensile strength of ligations of the tendon and sheath at two points one centimeter apart, thereby interfering with the blood supply, was then studied. The tendons were isolated through a small incision and with the tendon sheaths were tightly ligated in two places about one centimeter apart with heavy black silk. The overlying tissues were then sutured. Results are shown in Table II.

Four tendons and sheaths were then exposed, as outlined before, and severely traumatized with a Kocher hemostat and by further pounding the tendon until fraying occurred. Since this single procedure had not led to rupture after five weeks, strong ligatures were placed around the tendon and sheath above and below the injured portions. Two of these tendons were tested after three weeks, but separation occurred in both preparations at the insertion, detaching a small bony fragment. The other two were tested after four to five weeks. One separated at the insertion, although some necrosis was present at the injured area. The second one, however, ruptured at the injured area.

Two other tendons were then exposed, the sheath being retracted and the tendons crushed and pounded as described before. The tendons only were ligated above and below the injured areas and the sheaths carefully replaced by suture. These were tested five weeks later; one ruptured at the injured portion and the other at the muscle origin from the bone.

One tendon was cut one-half through and the sheath carefully sutured. When tested five weeks later, rupture occurred at tendon insertion. Another tendon, operated on at the same time, was severed one-half through and then ligated above and below the cut, the sheath being replaced. When tested five weeks later, rupture occurred at the point of injury.

To further test tendon strength and the strength of repaired, previously injured tendons, the following procedures were done. The Achilles tendon was exposed through a small opening and severed approximately three-fourths through. Tendon sheath and overlying tissues were then replaced. In five experiments casts were applied to the leg and foot to obtain immobilization, while in three the limbs were left free. The rabbits were allowed to run loose in their cages. Spontaneous rupture did not occur following either procedure. The casts were removed from the five animals and the muscle-tendon preparations tested four to five weeks after operation. They all held solidly in the injured portion, with separation occurring twice at the insertion, twice in the muscle belly; and in the other, the femur fractured. The three tendons, which had been cut without subsequent immobilization, on gross examination showed

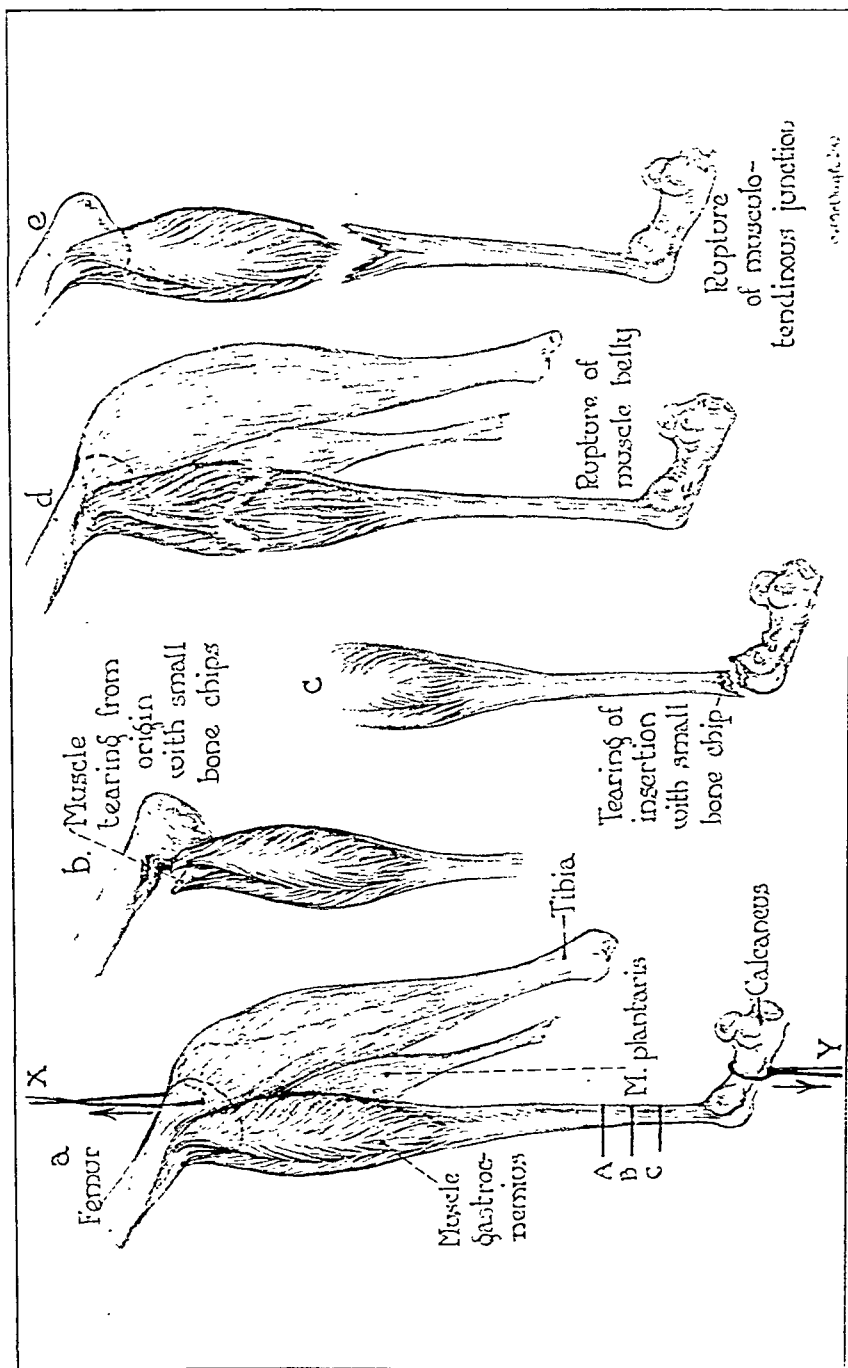


FIG. 6

Diagrammatic illustrations showing in *a* the muscle-tendon-bone preparation used to determine the point of separation. The wire *X* was suspended from an overhead beam. To wire *Y* was hung a bucket, into which weight was added. *b* illustrates where trauma and severance of tendon were done, and *d* and *c* where ligatures were placed, when these procedures were used. Drawings *b*, *c*, *d*, and *e* represent points of rupture in normal tendon and muscle (both clinically and experimentally) when subjected to indirect violence. It will be noted that normal tendon does not rupture.

evidence of separation of the cut portions; but spontaneous rupture of the cut portions had not occurred. When tested with weight three to four weeks after operation, they held solidly in the cut areas, separation occurring once at the tendon insertion, once in the muscle belly; and in the third, the femur fractured.

Completely severed Achilles tendons were then sutured. Strong ligatures of silk, one on each side of the suture line, were placed about the tendon. The sheath and skin were carefully sutured over the cut and casts applied to the legs. When examined four and five weeks later, necrosis at the ligated area had permitted wide separation of the tendon ends in two cases. In two others necrosis was present and the weak union was easily broken by hand. Two sutured tendons, which were not ligated and which were in legs to which casts had been applied, held solidly when weight was added five weeks later, rupture occurring once at the tendon insertion and once at the musculotendinous junction.

#### DISCUSSION

This type of experiment appeared to be the most satisfactory for testing the resistance, or tensile strength, of muscle and tendon. It does not offer an exact analogy to the conditions existing clinically; for in these experiments the animals were sacrificed and the muscle-tendon-bone preparation dissected free. However, the preparation was immediately wrapped in warm saline and tested so that no appreciable deterioration could have occurred. Another objection that might be made is that the skin and surrounding parts to the muscle, tendon, and bone had been removed. However, such a procedure allows a true test of the respective strength of the muscle, tendon, and bone in each preparation without other elements—such as skin and fascia—complicating the picture.

In a few of the tests it is noted that the femur broke before other parts gave way. This is somewhat objectionable as the femur was slightly weakened by the drill hole. However, the weights necessary to produce the fracture were often more than those required to cause rupture elsewhere in other specimens.

Whether weight was added either gradually or suddenly, there was no difference in the location of the rupture. In the former procedure, however, stretching occurred, which seemed to be largely in the muscle bundles and less in tendon fibers.

From these observations it is evident that normal tendon does not rupture. In fact a tendon must suffer considerable damage before it will rupture. Instead, the tendon insertion or muscle origin gives way, often detaching a small fragment of bone; or the muscle belly ruptures; or the musculotendinous junction separates (Fig. 6—*b, c, d, e*); or the bones fracture.

Wagner<sup>30</sup> briefly reviewed the subject of fractures (avulsion of bony fragments) by strong muscle contractions and added seven cases which included two of the spinous processes of the vertebrae, two of vertebral

transverse processes, two of the anterior superior spine of the ilium and one of the os calcis. This type of injury, which indicates a greater weakness of bone when compared to tendon and muscle, occurs most frequently before the epiphyses close. Adults, however, are not spared. In one of the cases reported by Wagner, the os calcis "fractured" during violent muscle contractions, while the male patient, aged thirty-four, was lying in bed. Honigsmann<sup>31</sup> mentions that subluxation or luxation of a joint occurs before rupture of a tendon. Among numerous clinical examples of the great tensile strength of tendon is one reported by Adams.<sup>32</sup> A seaman caught his right third and fourth finger tips in a door jamb. On jerking his hand away, he suffered a traumatic amputation at the distal interphalangeal joint of the third right finger and with it pulled away "fifteen inches" of the flexor profundus digitorum tendon and some muscle fibers. The rupture in this case occurred not in the tendon substance, but at the musculotendinous junction.

In these experiments approximately one-half of a tendon's fibers had to be severed to permit of immediate rupture when subjected to strain. Severing one-fourth of the fibers was not sufficient, nor was severe trauma from crushing and pounding. If, however, following any of the above injuries the blood supply to the involved part was obstructed, rupture occurred when test was made after four to five weeks.

On the other hand, when one-half of a tendon's fibers were severed, but with no obstruction to the blood supply, rupture did not occur when test was made after five weeks. Rupture did result after five weeks, if the blood supply had been obstructed.

Simple double ligation of a tendon, one centimeter apart, followed by suturing the tendon sheath, produced sufficient aseptic necrosis to cause rupture after five weeks when subjected to strain. The same was true when the sheath was ligated with the tendon. Obstruction to the blood supply of the tendon did not produce rupture before four to five weeks in these experiments.

Whereas severely traumatized tendons did not rupture four to five weeks later when tested with weight, it was interesting to note that, if the tendon was ligated on both sides of such an injury and the sheath sutured, rupture did occur in the injured area with strain. This presents evidence that the essential blood supply to a tendon, at least in rabbits, is carried in the tendon substance and not mainly in the sheath tissues. In fact severe injury to a tendon, as by crushing followed by stripping off the tendon sheath for two and five-tenths centimeters above and below the injured portion, did not cause rupture four to five weeks later, when tested with weight, if the tendon blood supply was unobstructed.

Microscopic examinations of the tendons with obstruction to the blood supply showed aseptic necrosis and absence of infection in the obstructed areas.

An example of assumed aseptic necrosis of tendon with subsequent rupture, resulting from obstructed blood supply (by fracture callus), is

illustrated in the case reported by Ashhurst.<sup>33</sup> Five weeks following a 'Colles' fracture, spontaneous rupture of the extensor pollicis longus tendon occurred after a grasping motion by the patient. At operation two weeks later, the proximal end of tendon was found densely adherent in fracture callus, but the distal end had pulled away and was frayed. No microscopic report was made.

Mason and Shearon<sup>34</sup> have recently called attention to the important rôle of both the tendon sheath and tendon in the repair of experimentally severed tendons followed by suture of the cut ends. The sheath, they stated, was more important than the tendon in the early bridging of the defect. After the fourth or fifth day the tendon proliferates and, if the gap is not too great, tendon cells bridge the defect in about two weeks. This union, however, broke when subjected to strain, as did similarly treated tendons between the fourth and fifth weeks postoperatively.

If conclusions applicable to clinical cases may be drawn from the results of the experiments in this paper, it is evident that in suturing tendons, either partly or completely severed, great care should be exercised, especially in placing sutures so that the blood supply to the tendon ends is not obstructed. It is not intended to minimize the possible importance of the sheath tissues in the repair of tendon injuries and the prevention of adhesions, but the apparent greater importance of viability of the tendon in reparative processes is emphasized.

#### SUMMARY OF EXPERIMENTS ON RABBITS

1. Normal tendon did not rupture when subjected to severe strain. Either the tendon insertion pulled away, or the muscle belly ruptured, or the musculotendinous junction separated, or the muscle origin pulled out, or fracture of the bones occurred. The tendon or muscle in pulling away from either insertion or origin, respectively, detached a small fragment of bone.

2. Approximately one-half of a tendon's fibers had to be severed to permit of immediate rupture when subjected to severe strain. Spontaneous rupture did not occur following severance of approximately three-fourths of a tendon's fibers under ordinary activity.

3. Obstruction to the blood supply of one centimeter of a normal tendon by double ligation caused rupture in this obstructed area as early as four weeks afterwards, when it was subjected to strain, even though the tendon sheath had been carefully replaced.

4. The blood supply of a tendon was more important in the reparative processes of injured tendons than the presence of the tendon sheath.

#### CONCLUSIONS FROM CLINICAL OBSERVATIONS

1. When a normal muscle-tendon system is subjected to severe strain, the tendon does not rupture. However, rupture may occur at the insertion of tendon to bone, at the musculotendinous junction, through the belly of the muscle, or at its origin from the bone. Either muscle or ten-

don may pull away a small fragment of bone. Sometimes the strain results in fracture or dislocation.

2. Disease processes in tendons predispose to their spontaneous rupture often from only slight strain.

3. Rupture of muscle fibers occurs following both direct and indirect types of trauma. Degenerative changes and disease processes in muscles predispose to their rupture.

4. Minimal to more extensive muscle ruptures occur following varying degrees of direct or indirect trauma and are often overlooked in clinical cases.

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# CHRONIC SCLEROSING OSTEOMYELITIS (GARRÉ)

BY JOSEPH G. WISNER, M.D., NEW YORK, N. Y.

*From the Hospital for Joint Diseases, New York*

This type of bone infection occurs frequently enough to cause some difficulty in diagnosis and treatment. It has thus far received scant attention from the orthopaedic surgeon. The literature has been fairly well covered in the isolated reports made by A. D. Kurtz, S. Fosdick Jones, and Hill and Penn. Five cases are added in the following report.

The most likely cause is bacterial, and trauma is usually the exciting factor. The difference between this and acute osteomyelitis is apparently one of degree. In three of our cases, the staphylococcus aureus was isolated. One must keep in mind the so called "silent foci" of Phemister. These, he believes, are mild foci of infection which have healed. They may be reactivated by trauma and so called to our attention.

From a pathological standpoint, two types of cases can be considered. In one, and this would be a true osteomyelitis, the marrow is first involved. It becomes cellular, shows an increased fibrosis, the cells of this fibroid tissue undergo metaplasia and become bone corpuscles. The marrow cavity is then entirely obliterated. In the second type the cortex is first invaded, the process starting as an osteitis. Here we have increased osteoblastic activity, so that the lamellae undergo progressive thickening and the marrow spaces become correspondingly reduced. The cortex becomes thickened, and the medullary cavity is diminished, but not obliterated. This bone is usually dense and like ivory, commonly described as eburnated bone. It is in this type that some bone lengthening may occur.

The symptoms are variable. They become important when adjacent joints are involved. In three of our cases (Cases 3, 4, and 5) our first impression was one of hip-joint disease.

## DIAGNOSIS

The diagnosis in most of the cases is not easy. Early cases especially are difficult to classify. On the strength of symptoms and signs alone it is virtually impossible to detect, except in a typical involvement of the tibia where it can be considered. It is simple to palpate thickening and elicit tenderness in a tibia or femur of a child, but quite impossible when the upper third of the femur is affected.

The x-ray is the one important aid in diagnosis, and this helps only in the late cases. An error is most apt to be made before definite bone changes are evident. Case 5 was treated as an arthritis of the hip for one year before the femoral thickening appeared. Case 3 was unclassified for some time.

The laboratory is of little help. There is usually slight elevation in leucocyte count. The Wassermann reaction is important.



TABLE I  
DIFFERENTIAL DIAGNOSIS (CLINICAL)

	<i>Garrè</i>	<i>Syphilis</i>	<i>Sarcoma</i>
Onset Fever	Usually present	None	None
Glandular Involvement	None	Frequently present	Occasionally present
Infiltration of Soft Parts	None	None	Present. Skin adherent
Loss of Weight	None	None	Present
Cachexia	None	None	Present
Wassermann	Negative	Usually positive	Negative

Differential diagnosis is extremely vital. Even in late cases, where x-ray findings are definite, it may be difficult to arrive at correct diagnosis. Its striking similarity to luetic osteoperiostitis and sarcoma is responsible for many delays in treatment. Here consideration of all signs and symptoms comes into use. The history, the course, the laboratory findings, and roentgenograms must be gone into carefully. Another possible source of error is a rare type (healed?) of osteitis fibrosa. Kocher believes that a considerable number of cured sarcomata are merely sclerosing osteomyelitis of long bones.

Tables I and II give the essential clinical and roentgenographic features of syphilis, sarcoma, and sclerosing osteomyelitis.

TABLE II  
DIFFERENTIAL DIAGNOSIS—BONE CHANGES (ROENTGENOGRAPHIC)

	<i>Garrè</i>	<i>Syphilis</i>	<i>Sclerosing Osteogenic Sarcoma</i>
Periosteum	No involvement	Involved irregularly	Irregular involvement perpendicular to shaft
Cortex	Thickened symmetrically	Thickened irregularly	Thickened (one side) or destroyed
Medulla	Narrowed or obliterated	May or may not be narrowed	Destroyed
Bone Production	Within shaft	Within shaft	In or about shaft
Bone Destruction	None	None	Present
Soft Tissue	No change	No change	Bone production into soft tissues
Localization	Shaft or near joint	Any portion	Usually ends of long bones

## TREATMENT

The treatment is operative. It is comparable to incision and drainage in other infections. Simple excision of a section of bone gives relief of symptoms and return of joint function, except where contractures are of long standing. Incision into bone apparently allows for a lessening of tension and reestablishment of circulation.

## CASE REPORTS

Our cases singularly fall into two groups. In the first the involvement is in the shaft of a bone, the tibia, or femur. Here the symptoms are mild, merely local pain, the disability slight, and the diagnosis relatively simple. In the second group the involvement is near a joint. The three cases that form this group are strikingly similar and by a strange coincidence were under treatment at almost the same time. In each, the upper end of the femur was affected. Here the symptoms are more marked, the disability is severe, and the diagnosis difficult; and here treatment by drainage of the bone produced marked improvement. All cases were treated at the Hospital for Joint Diseases.

CASE 1. J. D., aged six. Two years before began to have pain in the left leg, mostly at night. After a year pain became worse. Was taken to another hospital where diagnosis of obliterating osteomyelitis was made but nothing was done. At time of examination had pain in left leg, at times severe and worse at night. Examination disclosed a swelling of the left leg, an apparent anterior bowing of the tibia with some tenderness. White blood count was 15,500, with 68 per cent. neutrophils; Wassermann negative. No elevation of temperature was noted. The roentgenogram (Fig. 1) is self-explanatory.

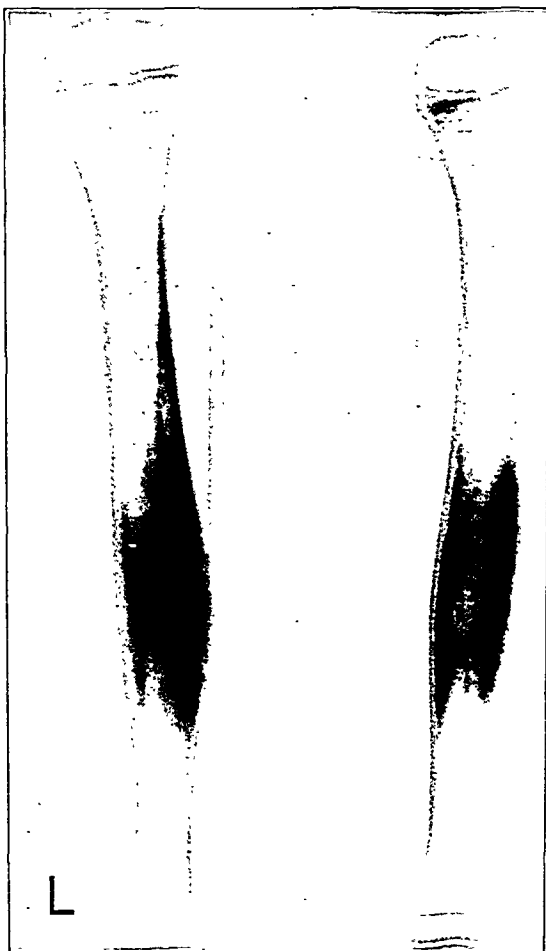


FIG. 1

Case 1. Shows increase in width of cortex, with some decrease in medullary cavity.

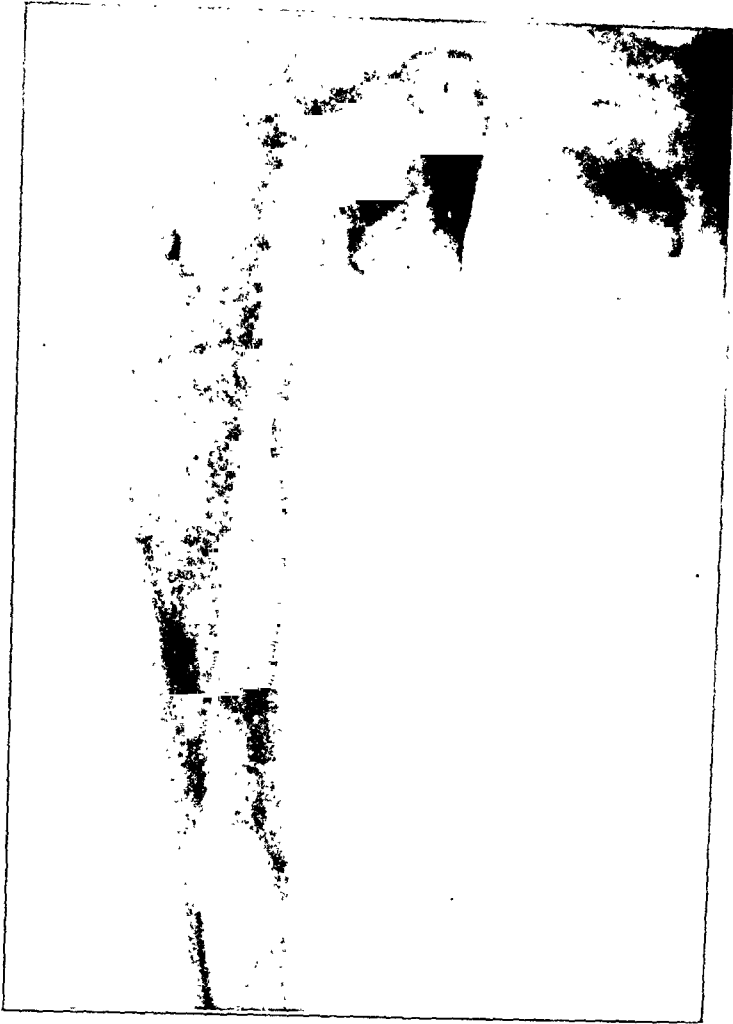


FIG. 2

Case 2. Shows increase in width and density of cortex in upper third of femur.

Had no limp. Examination was negative, except that the right thigh was one and one-half inches smaller than the left. Wassermann, negative; temperature normal. Roentgenogram (Fig. 2) showed osteitis of right femur, some endosteal bone proliferations, no destruction.

*Operation:*—Shaft of femur was exposed and surface of cortex found normal. Marked thickening of cortex, completely obliterating the medullary cavity, was found. About three inches of antero-internal cortex was removed. At one spot a mass of detritus, the size of a bean, was noted and curetted out. Wound was closed without drainage, no plaster applied. Culture was sterile; smear negative. Pathological report was osteosclerosis and fibrosis of bone with obliteration of medullary cavity. Patient was improved. A rise of temperature to 101 degrees occurred for two days postoperatively and then returned to normal. Wound healed by primary union.

*Follow-up:*—Two years later, no complaints, no disability.

CASE 3. P. K., aged eleven, was admitted first on January 27, 1929. Had had pain in right hip at intervals for one year. Pain was first noticed after strenuous exercise in school; later appeared after much walking. Pain was worse at night. Limping during the past six months had become progressively worse.

*Examination:*—Motion at right hip limited as follows:—angle of greatest flexion, 90 degrees; abduction, 30 degrees; internal rotation, 10 degrees; angle of greatest extension, 165 degrees; adduction, 10 degrees; external rotation, 15 degrees.

Operation was advised and performed. The periosteum was found abnormally thick and the cortex hard; no pus noted. Piece of tibia was removed. Wound was closed tight. Culture of marrow cavity revealed staphylococcus aureus. Pathologist reported that smear from marrow cavity showed chronic osteomyelitis, but that bone sections were normal.

The patient was relieved of pain. The wound healed by primary union. No postoperative elevation of temperature occurred. Letter from patient one year later reported complete relief of pain and gradual reduction of swelling. No late x-ray could be obtained.

CASE 2. K. C., aged ten, was admitted April 8, 1926. Had had pain in right thigh for about two years which followed a blow by a baseball. Pain was worse at night; not aggravated by walking.

Roentgenogram (Fig. 3) showed atrophy of head and neck, irregular osteoperiostitis of shaft of upper third of femur. Neck seemed shortened. Laboratory report showed Wassermann negative; white blood cells, 10,500 with 75 per cent. neutrophils; calcium 10.6 grams, phosphorus 4.35 grams per 100 cubic centimeters. On account of little pain, patient was allowed to go home and return to dispensary for observation.

Her symptoms increased and she was readmitted March 4, 1929 (one month after first admission). Examination at this time showed: angle of greatest flexion, 110 degrees; abduction, 20 degrees; internal rotation, 5 degrees; angle of greatest extension, 145 degrees; adduction, 10 degrees; external rotation, 10 degrees.

*Roentgenographic report:* "Neck seems shortened. There is some atrophy of head and neck; there is an irregular osteo-

periostitis of the shaft of the upper third of femur on the inner side."

*Operation, March 6, 1929.* Eight-inch incision, exposing upper third of femur and neck. Cortex of neck near outer aspect was found very thin and gave impression of egg-shell crackle; it looked bluish. The trochanter minor was apparently replaced by an overgrowth of cortex. This was removed for distance of two inches. Although markedly thickened, the cortex was not unusually dense. On opening the medullary cavity, a gush of yellowish material was observed. This appeared to be broken down fat marrow. A drill hole was made up into the head, but revealed nothing. Wound was closed tight and light plaster-of-Paris spica applied. Temperature before operation was normal; afterward there was a rise to 101 degrees for two days and a return to normal.

Pain was relieved after operation. Plaster was removed in three weeks. Patient walked with crutches for several weeks. Culture showed a scanty growth of staphylococcus aureus. Pathological report:—Chronic osteomyelitis.

*Follow-up, May 19, 1931.* No pain; no limp. Flexion was limited to 90 degrees, otherwise motion at hip was normal. Roentgenograms showed that neck was assuming normal shape; width of shaft through trochanter was nearer normal. There was still evident increase of density along inner border of upper two inches of shaft and lower border of neck.



FIG. 3

Case 3. Shows irregular osteoperiostitis of inner aspect of upper third of shaft of femur; slight atrophy of head and neck.



FIG. 4-B. Left hip.

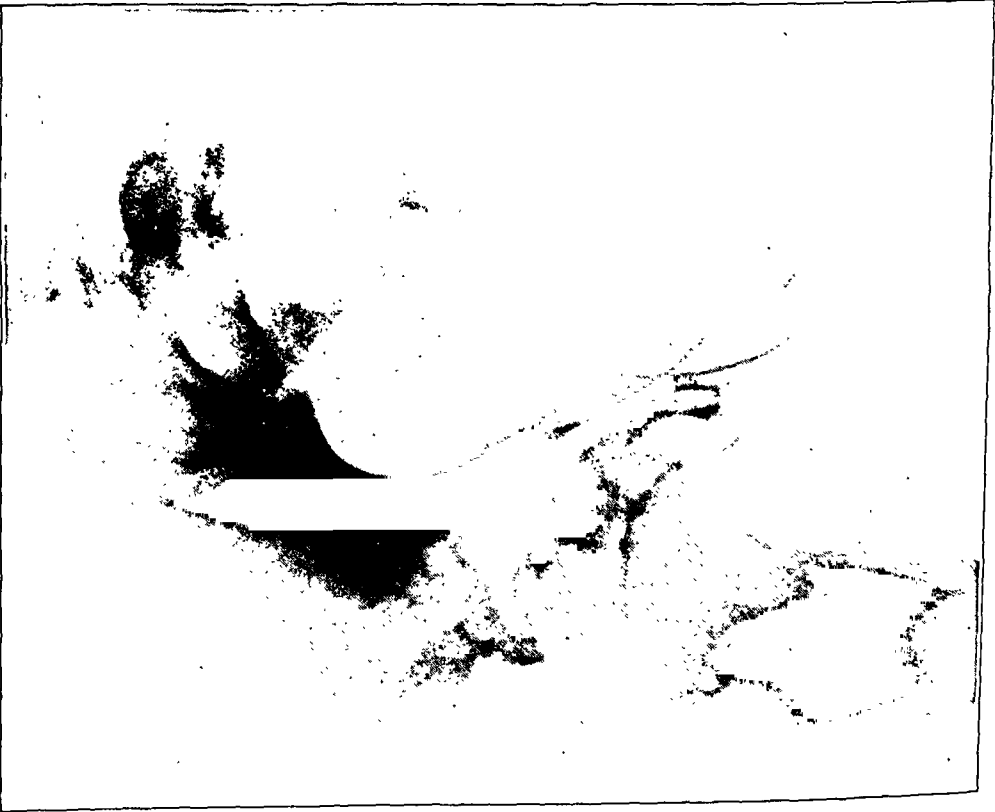


FIG. 4-A. Right hip.

Case 4. Shows increase in density of cortex of right femur and some widening at the base of the neck; there is a localized area of rarefaction suspicious of abscess.

CASE 4. Jennie C., aged twelve, was admitted May 13, 1929; discharged June 25, 1929. Complained of pain in right hip, which began two months before while doing exercises in school. Pain was persistent and worse at night. Girl walked with limp. This limp appeared soon after onset of pain: was increasing.

*Examination:* Patient walked with limp on right side; right hip was held in flexion. There was slight tenderness over greater trochanter. Angle of greatest flexion was 80 degrees; angle of greatest extension, 160 degrees; internal rotation limited; external rotation normal. Measurements were:

Right A\*—31 inches;  
Right tibia—12½ inches;  
Right calf—8½ inches (atrophy);

Left A\* —31 inches;  
Left tibia—12½ inches;  
Left calf—8¾ inches.

Blood count showed hemoglobin of 80 per cent.; white blood cells 7,950, with 63 per cent. neutrophils. Wassermann was negative; quantitative tuberculin test, negative. X-ray 16970 (Figs. 4-A and 4-B) showed an increase in width of femur at base of the neck; some increase of density in bone in this area, and slight suspicion of bone abscess. This case was similar to Case 3. Operation was decided on.

*Operation,* May 15, 1929. Greater trochanter and anterior aspect of femoral neck at intertrochanteric line were exposed. Periosteum was much thickened. Piece of bone was removed. It looked pale, had a white, ivory-like appearance and felt hard as ivory. No pus was noted; marrow seemed pale. Specimen was sent to laboratory for culture and microscopic examination.

*Pathological report:* "Low-grade non-suppurative inflammatory process with atrophy; slight resorption and some periosteal new bone formation." Smear was negative; culture, sterile; guinea-pig inoculation, negative. Because a rather large piece of bone was removed, vaselin gauze packing was inserted to fill in cavity and plaster-of-Paris spica was applied. This was removed in four weeks. Temperature was normal before and after operation. Patient was discharged June 25, 1929, with wound practically healed.

*Follow-up,* January 1932. No complaints; walks without limp. Range of motion in right hip is excellent. Angle of greatest flexion, 50 degrees; angle of greatest extension, 180 degrees; rotation normal. X-ray (Fig. 5) shows neck and upper end of shaft almost normal. Area of excavation just below trochanter is filling in. Where abscess cavity was suspected, bone is negative.

\* Anterior superior spine.

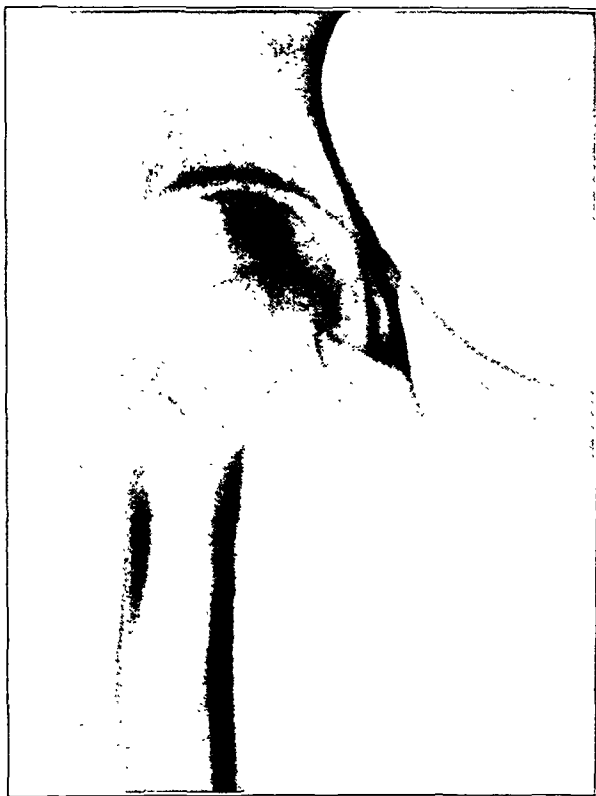


FIG. 5

Case 4. Follow-up x-ray. Upper end of shaft and neck are almost normal; outer cortex shows osteotomy.



FIG. 6-B. Left hip.



FIG. 6-A. Right hip.

Case 5. Shows increase in density and width of cortex of left femur, inner aspect of upper third; slight atrophy of head of femur.

CASE 5. S. A., aged ten. First Admission, November 6, 1929–November 26, 1929. Second Admission (one year later) September 10, 1930–December 7, 1930. In May 1929 had tonsillitis. After this illness had pain in left hip and limp on left side. Treated in Out-Patient Department with plaster spica. Pain was relieved, but limp remained. Admitted into hospital.

Examination was negative except for local condition about left hip. All motion was limited; flexion contracture of 20 degrees. Blood count showed white blood cells, 7,750, with 60 per cent. polymorphonuclears. Wassermann was negative; tuberculin test, negative. Roentgenogram 19087 (Figs. 6-A and 6-B), taken November 6, 1929, showed slight atrophy of capital epiphysis; slight increase in density of bone on inner border of cortex of neck and upper two inches of shaft of femur.



FIG. 7

Case 5. Shows increase in density of inner cortex of femur with increase in width of femur at base of neck; compare with Fig. 3.

*Treatment:*—Traction to overcome flexion contracture; plaster spica three months.

Since limp continued and flexion contracture returned, he was readmitted on September 10, 1930. X-ray 23013 (Fig. 7) showed increased density of neck and upper two inches of shaft. Neck was thickened and shortened. There was a striking similarity to picture of Case 3 (Fig. 3).

*Operation,* October 20, 1930. Greater trochanter and shaft were exposed. Cortex was apparently negative (inner cortex was not carefully exposed). Several drill holes were made and curettings sent to laboratory. No pus was encountered. Wound was closed tight and spica applied for two weeks. Temperature before operation was normal; afterward rose to 102 degrees for two days; then returned to normal. Had stitch abscess which cleared up in few days. Wore brace for three months.

*Pathological report.* "In one place increased connective tissue is observed with some cells that may be a nest of inflammatory cells." Smear was negative. Culture showed staphylococcus aureus.

Discharged December 7, 1930 with brace.

*Follow-up,* January 1932. No complaints, no disability. Complete range of motion of left hip except for slight limitation of internal rotation. X-ray (Fig. 8) shows that increased density of inner aspect of neck and shaft has disappeared; neck, though still thickened, is more nearly the normal shape.





FIG. 8

Case 5. Follow-up x-ray shows return to normal of cortex of femur; neck is still shorter and femur wider at base of neck.

## SUMMARY

Five cases are reported which fall into two distinct groups. In the first group there is the type of case most often reported as chronic sclerosing osteomyelitis. Here the shaft of a long bone is involved, the symptoms are fairly clear, and the diagnosis readily established by the roentgen ray. No difficulty was encountered in their treatment.

The second group is more complicated. In the reports searched no mention of such a type was noted. The similarity in localization,

symptoms, and roentgen-ray findings is interesting. All were treated in the same way; they were relieved by operation and have remained well. The wounds stayed closed and no recurrences, either local or metastatic, have thus far been observed. In two, cultures gave growth of staphylococcus aureus. Late x-ray examinations show a gradual return to normal contour and texture, once the irritant has been removed.

Acknowledgment with thanks is made to Dr. Leo Mayer, Dr. Harry Finkelstein, and Dr. Herman C. Frauenthal for permission to use their cases.

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# RECURRENT DISLOCATION OF THE SHOULDER. NICOLA OPERATION

## WITH REPORT OF CASES \*

BY MARCUS H. HOBART, M.D., F.A.C.S., EVANSTON, ILLINOIS

*From the Department of Surgery of Northwestern University Medical School*

In 1929 Nicola <sup>1</sup> introduced his operation for recurrent dislocation of the shoulder which has as its principle the retention of the head of the humerus within the glenoid fossa by means of the long tendon of the biceps. This tendon is transplanted into a tunnel through the humeral head and acts to hold the head in place.

This operation of transplanting the long tendon of the biceps seems very logical. It is anatomical, physiological, and simple; and it remains only to stand the test of time as to its results. There is the theoretical objection that the tendon may give way, but that is also possible with any of the other methods, and in this operation the living biceps tendon should be a better and more lasting protection than any other form of suture or stay.

We suggest and have used two modifications of the technique originally devised by Nicola; these have been in part adopted by him, although not yet reported.

1. An incision is used about a half-inch posterior to the anterior border of the deltoid, and the fibers of that muscle are spread longitudinally. With this incision there is less danger of damaging the cephalic vein, which is located at the anterior border, and exposure of the bicipital groove and tendon can be obtained without cutting any of the fibers of the deltoid at their origin on the clavicle.

2. The tunnel in the humerus is so directed that the entrance for the tendon is near the proximal end of the bicipital groove and not in the middle of the head of the humerus (Fig. 1).

This gives a more normally anatomical course for the tendon, obviates any sharp angle in it, and avoids the continual crushing effect of the humeral head on the tendon in the glenoid fossa.

### TECHNIQUE OF TENDON-TRANSPLANTING OPERATION

1. Thorough sterile preparation of the shoulder field of operation twenty-four hours in advance. This means shaving area, green soap, ether, alcohol, tincture of iodine, and a sterile dressing. Repainted with tincture of iodine at time of operation.

2. "Lane-style" technique throughout the operation,—i.e., instrument operation.

\* Reported before the Joint Meeting of the American Academy of Orthopaedic Surgeons and the Clinical Orthopaedic Club at Chicago, Illinois, January 13, 1933.

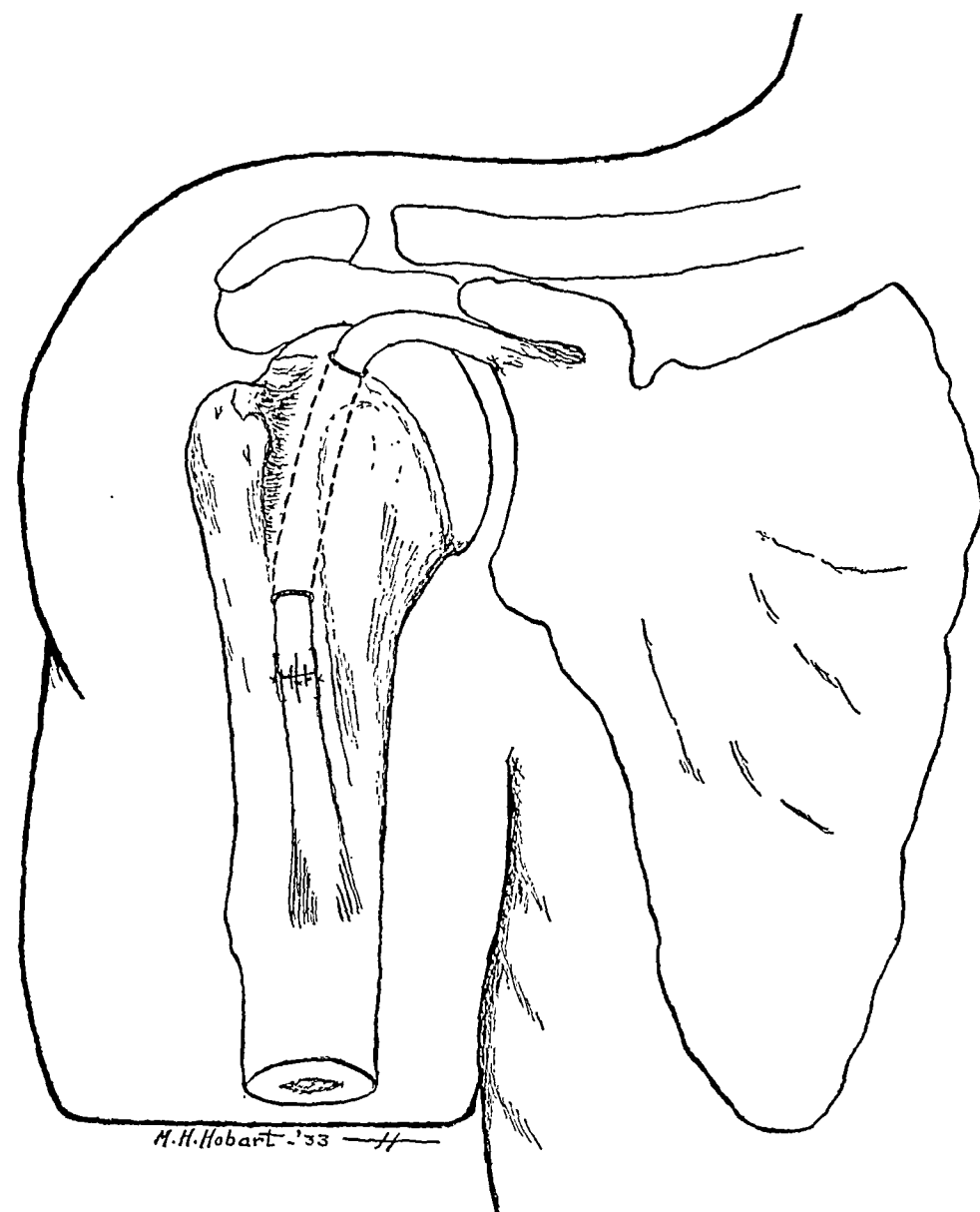


FIG. 1

Modified Nicola operation for recurrent dislocation of shoulder, showing the tunnel for the long tendon of the biceps muscle through the humerus under the bicipital groove.

3. Position on the table: patient on his back with sand bag under shoulder, humerus rotated outward about ninety degrees. This allows the bicipital groove to point anteriorly. The elbow is flexed to about forty-five degrees and kept in that position for two to three weeks post-operatively.

4. General anaesthetic used.

5. Incision, as above, one-third to one inch posterior to anterior border of deltoid muscle, and fibers separated longitudinally, exposing the capsule near the bicipital groove.

6. The tendon of the long head of the biceps is exposed by cutting

transverse humeral ligament over the tendon in the bicipital groove, splitting the capsule in the direction of the tendon. The bicipital arch of the circumflex artery which accompanies the tendon in the groove should be avoided if possible.

7. The long tendon of the biceps is divided between stay sutures at one inch distal to the margin of the transverse humeral ligament.

8. A hole is drilled through the neck and head of the humerus, being just below the transverse humeral ligament, and using a quarter-inch drill. This is so directed that it comes out near the proximal end of the bicipital groove at the margin of the humeral head, as above described.

9. A probe is passed through this tunnel, from below upward, and the cut end of the proximal tendon threaded onto it and pulled back through the tunnel. The two cut ends of the biceps tendon are sutured together with black silk.

10. Tension is made on the proximal part and sutures passed through the tendon and periosteum to prevent tension on the newly sutured section of the tendon.

11. The transverse humeral ligament and capsule are sewed with a continuous, No. 1, plain catgut suture; the skin closed with silk or dermal suture.

12. The arm is put up in a Velpeau bandage, reenforced with adhesive plaster, with the elbow flexed to forty-five degrees, and left there for three weeks.

The patient is then allowed to resume motion gradually. Massage, gentle motion, and heat are advisable. The patient is cautioned not to use arm completely for a number of weeks.

#### CASE REPORTS

CASE 1, H. S., male, aged twenty-six years. Fifteen or sixteen dislocations of right humerus previous to May 12, 1932. Operation (Nicola) at Cook County Hospital. After leaving hospital in two weeks, had an accident resulting in fracture of right elbow which healed perfectly, with good motion. After that he kept the arm completely abducted each night for three weeks, on the advice of someone else. He had used the arm for everything. About December 20, 1932, while putting on a heavy overcoat, he said his shoulder went out again and right back. Since that time he has had no more trouble.

CASE 2, E. G., male, aged nineteen years. Injured left shoulder one year ago playing football, twelve recurrent dislocations. November 17, 1932, operation (Nicola with anatomical replacement of tendon), at Cook County Hospital. Result: all motion, no recurrence.

CASE 3, C. J., male, aged twenty years, had had six dislocations of right humerus. November 29, 1932, operation (Nicola, revised as in Case 2), at Cook County Hospital. Result: using arm, all motion present, no recurrence.

#### SUMMARY OF CASES

Of the three cases operated on, Case 1 (Nicola) has had one slight recurrence, but this man has given his shoulder much abuse and violent use since the operation, ten months ago. Cases 2 and 3 (Nicola, with anatomical replacement of biceps tendon) have given good results.

## CONCLUSIONS

1. The Nicola operation offers a comparatively simple means of treating recurrent dislocations of the shoulder.

2. The revised technique as here suggested, of placing the long head of the biceps through a tunnel, nearer the bicipital groove, instead of through the humeral head, gives a more anatomical result and should obviate angling the tendon and crushing it in the glenoid fossa.

3. Enough time has not elapsed, nor have enough cases been reported to determine its permanent value.

4. Three Nicola operations are reported.

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## FIXED SKELETAL TRACTION IN FRACTURES OF THE LEG

BY RALPH M. CARTER, A.B., M.D., F.A.C.S., GREEN BAY, WISCONSIN

For the treatment of difficult fractures of the leg below the knee, the application of fixed skeletal traction by means of the Kirschner wire has proved highly successful in my experience.

The necessary equipment consists of a Kirschner wire outfit, a traction frame for fractures of the lower leg as suggested by Böhler, and a so called Marburg distraction apparatus. This latter consists of two Kirschner traction bows, whose extremities are drilled to receive the ends of detachable lateral bars, connecting one bow with the other by means of turnbuckles: the lengths of these bars may be varied as indicated.

To make use of this method in fractures of the tibia, the patient is anaesthetized, a Kirschner wire is put through the os calcis, in the usual manner, and the traction bow applied. The leg is then placed in the traction frame, as shown in Figure 1. In doing this, there must be sufficient padding at the bend of the knee to prevent undue pressure on the skin; a spring balance is also interposed between the traction bow and the traction screw. This is shown in the illustration.

The traction screw at the end of the frame is now turned down until the spring balance registers about twenty-five pounds; in most cases this will be found to be sufficient to overcome any shortening which may be present and, upon palpation at the site of fracture, the ends of the fragments will be found to be in contact. In certain cases, apparently in those in which the sharp end of a bony fragment has become embedded in muscle, more traction is necessary; in such cases, it may readily be applied by means of the traction screw, until the spring balance shows forty to forty-five pounds. In those cases in which this amount of traction is necessary, a blanching of the toes and foot will occur, due to compression of the blood vessels at the knee. This need occasion no alarm; such traction, if necessary, may be maintained for fifteen to twenty minutes, or even longer, with no after-effects whatever. As soon as the cast is applied and the traction relieved, the toes immediately take on their natural color, and no pain or soreness at the knee results.

When the shortening has been overcome by a sufficient amount of traction, palpation will usually show that the fragment ends are in contact; if there is a gap in the continuity of the bone, the traction is released until this gap disappears.

By means of a portable x-ray unit, films are now made in two planes. In most cases, satisfactory reduction will be found to have taken place; occasionally some lateral displacement may persist, which is readily corrected by manual pressure on opposite sides of the leg.

Not infrequently, also, there is seen to be overcorrection of the shortening, with slight diastasis of the fragment ends, particularly in

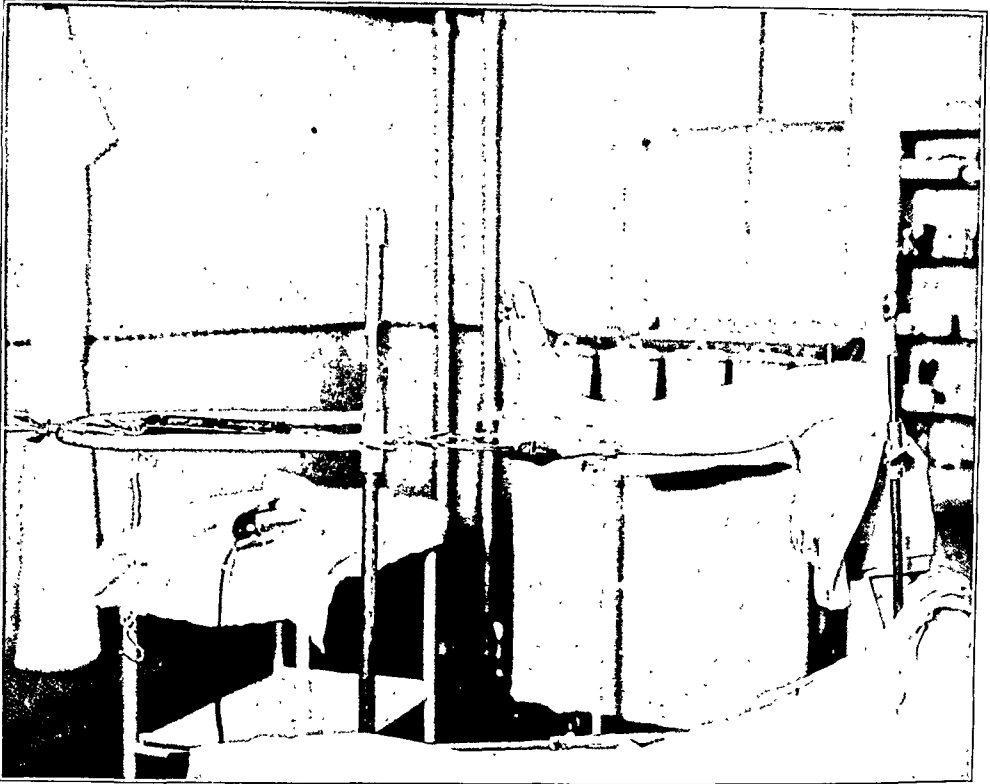


FIG. 1

Leg in traction frame, showing wire through os calcis, padding at knee, and spring balance. Reduction of fracture complete.

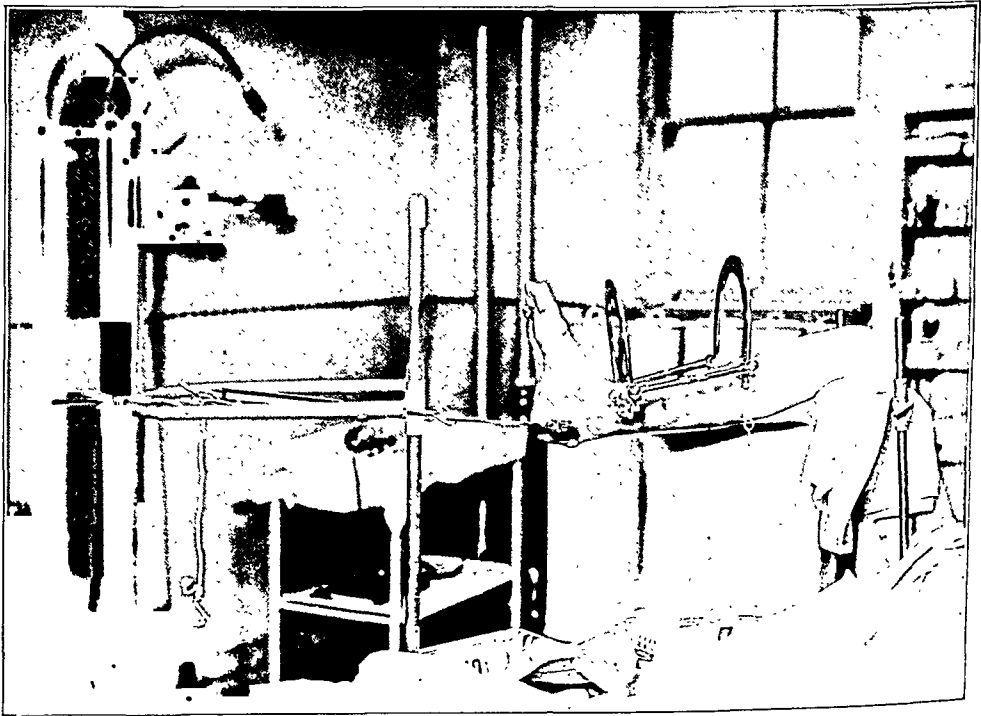


FIG. 2

Apparatus for fixed traction in cast in place. Leg ready for plaster.

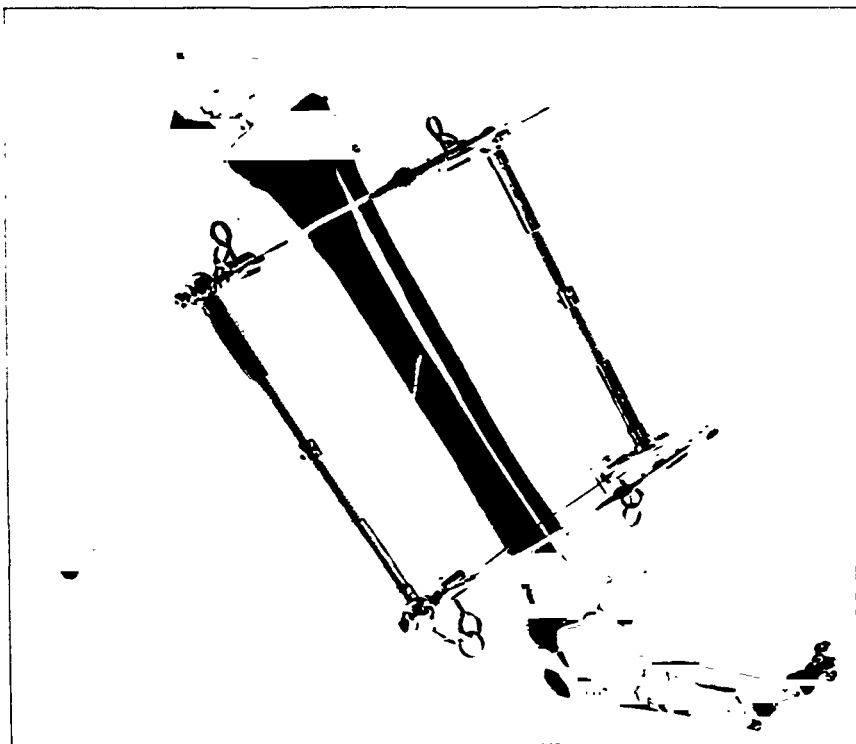


FIG. 3

Skeletal relationship of wires. Site of fracture indicated by black line.

transverse or slightly oblique fractures. If this is the case, the traction must be further released. This last point is particularly important; with the powerful traction, overcorrection and separation of the fragment ends readily take place, and, if allowed to remain, will give rise to delayed union, if not to its complete absence.

When reduction is satisfactory, the next step in the procedure is carried out. Two heavy Kirschner wires are put through the tibia above and below the site of the fracture. Over the protruding ends of both wires, before the traction bows are applied, are slipped small set screws, which for the time being are left loose. The traction bows are now put in place and the wires tightened as usual. The lateral bars of the distraction apparatus are next fixed to the two Kirschner bows, and the turnbuckles adjusted to the proper length. By this means, the fragments are firmly fixed in their reduced position, and no displacements can possibly take place during the application of the cast. This step in the procedure is shown in Figure 2. The skeletal relationships of the two wires are shown in Figure 3.

An unpadding plaster cast is now applied, beginning with a posterior molded splint. In applying this cast, great care must be taken to see that it fits snugly about the wires in the shaft of the tibia. The leg with the cast applied is shown in Figure 4.





FIG. 4

Leg still in traction frame with cast applied.

As soon as the cast has firmly set, the leg is removed from the traction frame. The small set screws which were previously slipped over the ends of the wires are brought snugly up against the cast and tightened. By this means, the tension is kept on the wires in the absence of the traction bows. The latter, together with the lateral bars, are now removed and the protruding ends of the wires cut off close up to the set screws. The Kirschner wire through the heel is also removed. The dressing at this stage is shown in Figure 5. It is completed by throwing a few turns of plaster bandage over the set screws as a protection.

By means of this procedure, difficult fractures of the tibia can be readily reduced, and what is more important, owing to the fact that the fragments are firmly united to the cast by means of the wires, new displacements cannot take place, and reduction is easily maintained until the bony union is firm. The roentgenograms from an illustrative case are shown in Figures 6 and 7.



FIG. 5

Completed dressing. Note set screws maintaining tension of wires.

The distraction apparatus alone can be used to effect and maintain reduction, although it is preferable to use it in connection with a frame and traction to the os calcis, as above described. If, however, a traction frame is not available, the method of use is briefly as follows:

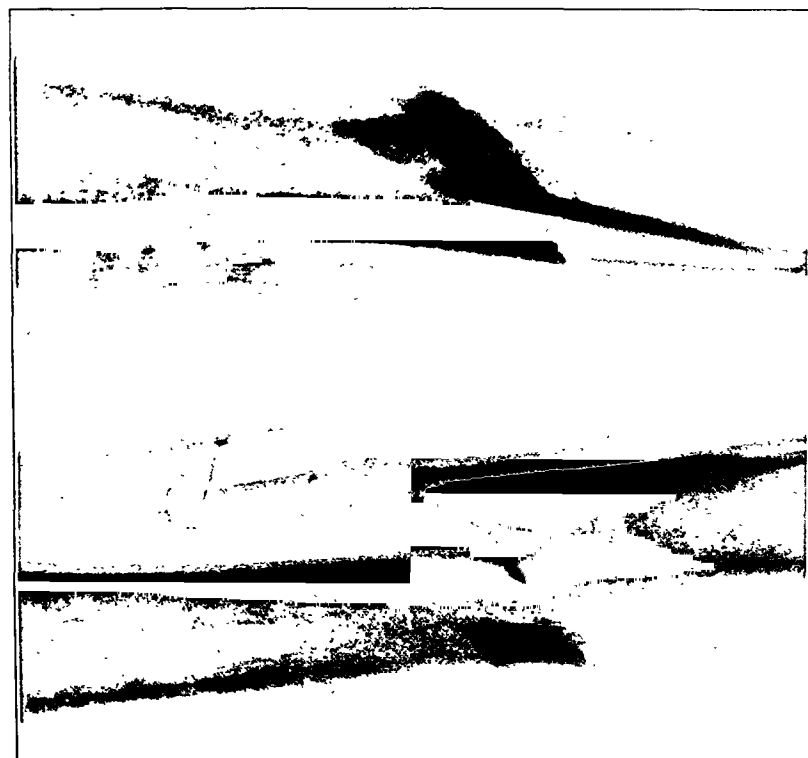


FIG. 6  
Fracture of both bones of leg before reduction.

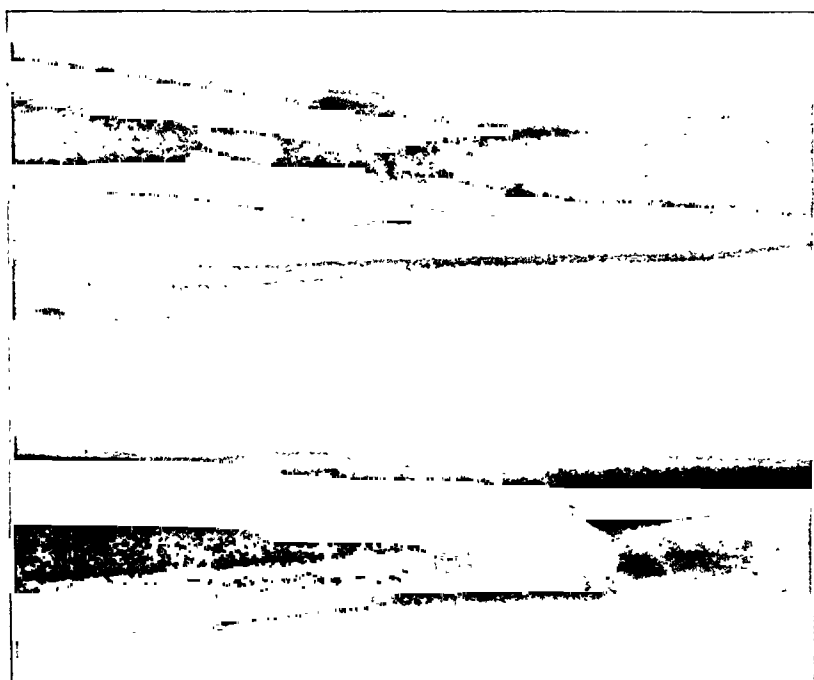


FIG. 7  
Fracture of both bones of leg after treatment.

Under strictly aseptic precautions, as always, the wires are put through the bone above and below the site of fracture. The set screws, bows, and lateral bars are then applied, and traction is obtained by lengthening the lateral bars sufficiently to bring the broken ends into contact. An unpadded cast is then put on, the set screws tightened, and the apparatus removed. Without the use of the traction frame, however, unless great care is exercised, new displacements are possible during the manipulations attendant upon the application of the cast, and, for this reason, the use of the frame is preferable.

The following day, after the plaster has firmly set, the usual iron stirrup is applied to the cast, extending below the sole of the foot, and the patient becomes ambulatory.

The progress of callus formation is noted by means of an occasional roentgenogram. In most cases, union is sufficiently firm at the end of about four weeks so that the wires and cast may be removed and a new cast without wires put on if desired, without danger of causing displacement of the fragments. However, in the absence of any indication to the contrary, this is not necessary, and the original cast may remain until union is firm, and a cast is no longer needed.

This method of treatment is reported because it is one which gives highly satisfactory results in a class of fractures which frequently occasion extreme difficulty. No originality is claimed for it; the same principle is utilized by Böhler in fractures below the knee, the difference being that he makes use of rustless steel nails for obtaining the fixed traction instead of the Kirschner wire. These nails must be driven or forced through the bone; this of course can be readily done, but the insertion of the Kirschner wire is much simpler and easier. The nails also give rise to much more tissue damage than do the wires, on account of their much larger size; hence, irritation and the chance for infection are increased. For these reasons, I feel that the method which makes use of the wires and which has been described is preferable.

NOTE.—Since the above article was accepted for publication, in reviewing some fracture literature, I have found a paper on the same subject by Dr. J. Warren White, of Greenville, South Carolina (White, J. W.: Plaster Cast, Bone Pin Method in Fractures of the Lower Leg. *Southern Med. J.*, XXV, 218, 1932). The method of treatment described in his paper is similar in many of its details to the one described by me. Although my work has been done independently and with no knowledge of his method, I feel that in justice to Dr. White, this acknowledgment should be made. *R. M. Carter.*

# EXTRA-ARTICULAR BONE-GRAFT TREATMENT FOR TUBERCULOSIS OF THE HIP JOINT

WITH A SPECIAL STUDY OF THE PRIMARY FAILURES OF FUSION

BY SYLVAN L. HAAS, M.D., SAN FRANCISCO, CALIFORNIA

*From the Shriners' Hospital for Crippled Children*

Sufficient time has elapsed since the introduction of the extra-articular graft operation to allow some deduction to be made as to the advisability of instituting this particular operative procedure for the cure of tuberculosis of the hip joint. To date the published reports are not sufficiently large to allow the surgeon to formulate some definite conclusions, but there should be an increasing number in the next few years.

In interpreting the reports, one must bear in mind certain significant facts that may play a part in leading to error. Thus there is always the possibility of a recrudescence after an apparent cure, even after the lapse of a number of years. However, one may be reasonably certain of a cure if a firm, bony ankylosis has taken place in the diseased joint. It must not be forgotten that there is always a chance for error in diagnosis, especially in the extra-articular method, as particular effort is made to avoid invasion of the diseased joint, and no material is obtained for certain diagnosis by microscopical examination and guinea-pig test. In other words it becomes necessary to rely on the presumptive evidence furnished by clinical history and findings and roentgenographic examinations.

In the papers by Albee<sup>1</sup>, Hass<sup>2</sup>, Maragliano<sup>3</sup>, Kappis<sup>4</sup>, Hibbs<sup>5</sup>, Wilson<sup>6</sup>, Ghormley<sup>7</sup>, Sorrel<sup>8</sup>, Eikenbary<sup>9</sup>, Schumm<sup>10</sup>, Mathieu<sup>11</sup>, Nové-Josserand<sup>12</sup>, Leriche and Stricker<sup>13</sup> different modifications of the extra-articular and intra-articular bone-graft operations are described in detail. Good results have been obtained by all of the methods but here again sufficient statistics have not been presented to allow the drawing of any conclusions as to the preferable type. Even after the publication of a large number of reports it will be necessary to exercise care in drawing conclusions and avoiding an erroneous interpretation. A few of the facts that must be considered are: the age of the patient at the time of operation, the duration of the disease, virulence or acuteness of the process, careful operative technique, postoperative care, time of observation, and careful follow-up of the patient. It is possible that one type of operation may give a uniformly higher percentage of good results. It is believed that a certain number of failures will occur regardless of the type of operation. A study of these unsuccessful results in an effort to determine the causative factors should provide some interesting results. It is to be hoped that the details presented in this report may aid in solving some of

the problems that are encountered and decrease the failures, or lead the way to a uniformly successful method.

The present study is based upon fifty patients operated upon at Shriners' Hospital in San Francisco with the extra-articular bone graft. The technique of the operation was relatively uniform throughout the series. The joint capsule was exposed by a Smith-Petersen approach, after which a free or pedicle graft from the ilium was utilized to bridge the gap from the raised-up trochanter to the side of the ilium outside of the joint capsule. If tuberculous material was encountered in the ilium or elsewhere outside of the capsule, the operation was completed in the usual manner. Some of the cases were operated upon even in the presence of a persisting sinus. The operative wound was closed in layers, after which a single or double plaster spica was applied. The patient was kept recumbent until union was well established.

There was no operative mortality in this group of patients and there was a very noticeable beneficial improvement in the physical condition of all patients very soon after the operation. All the patients, with one exception, were definitely benefited by the operation. One patient who had a sinus at the time of operation made good progress, and union was almost complete when he developed a fatal meningitis about the eighth month after operation.

Sinuses were present in six patients at the time of operation, but healing took place in all but one patient. Sinuses appeared in three patients after operation. One of these subsequently healed and it is anticipated that the other two, which are gradually healing, will close permanently.

In twelve patients tuberculous material was encountered during the operation, but a sinus followed in only one patient.

The average age of the patients at the time of operation was seven years.

The average duration of the disease before operation was four and three-tenths years.

The average time after operation before the patient walked was one year and four months for those requiring one operation.

The longest time period of observation since operation has been eight years. The disease appears to be cured or arrested in every patient, but it will take a longer period before more definite final conclusions can be drawn.

#### SPECIAL STUDY OF PATIENTS REQUIRING MORE THAN ONE OPERATION

In reviewing these fifty cases it was rather surprising to find that twenty patients, or forty per cent. of the total, required more than one operation before a successful result was obtained. In view of the large number of secondary operations, it was thought that a detailed study would throw some light on the cause of the failures and possibly pave the way for a method of securing more primary successful results. It may

be possible to determine from this study the type of case in which the prognosis for operative success will be poor. If a failure can be anticipated, then some supplementary procedure may be instituted to assure a good primary result. The study will be taken up with regard to the following subjects:

1. Age at time of operation.
2. Duration of disease before operation.
3. Time after operation before patient was able to walk unassisted.
4. Type of deformity at time of operation.
5. Appearance of head of femur in roentgenogram.
6. Appearance of acetabulum in the roentgenogram.
7. Distance of trochanter from the ilium.
8. Mobility of femur at time of operation.
9. Presence of sinus at operation.
10. Presence of abscess at operation.
11. Tuberculous material encountered during operation.
12. Progress of disease process.
13. Acuteness of the disease.
14. Use of free or pedicle iliac graft.
15. Single or double spica applied after operation.

For simplicity of study it may be best to group the subjects under several headings, as: (1) time element, (2) pathological and clinical findings, (3) operation. As nearly as possible each type will be tabulated and studied in relation to the patients requiring either a primary operation or a secondary operation.

TABLE I  
AGE, DURATION, AND TIME BEFORE OPERATION

	Average Age at Time of Operation	Duration of Disease Before Operation	Time After Opera- tion Before Patient Was Able to Walk Unassisted
Primary successful result . .	7.9 years	4.9 years	1.3 years
Secondary successful result <sup>1</sup>	7.8 years	3.5 years	2.3 years

The average age at time of operation was about the same in both groups, but in general the patients were younger in the group requiring more than one operation.

The duration of the disease before operation was longer in those patients requiring only one operation. Thus it may be inferred that the longer the duration of the disease the more likely it is to be quiescent and, therefore, more amenable to treatment. This factor will be further elaborated in some of the other tables.

There was, of necessity, a longer time period in those patients requiring two or more operations.

TABLE II  
DEFORMITY AT OPERATION

	Adduction Deformity	Abduction Deformity
Primary .....	60 per cent.	40 per cent.
Secondary .....	75 per cent.	25 per cent.

In Table II it is noticed that there was a larger proportion of cases with adduction deformity requiring more than one operation. This factor is not so important in view of the rather large number of cases in which a primary result was obtained in the presence of an adduction deformity.

TABLE III  
PATHOLOGY

	Erosion of Head		Acetabular Involvement		Distance of Trochanter to Ilium		Mobility at Time of Operation	
	Slight	Great	Slight	Great	Short	Long	Slight	Great
	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
Primary .....	10	90	30	70	73	27	73	27
Secondary .....	30	70	25	75	50	50	50	50

It is evident from Table III that where there was a greater destruction of the head and acetabulum there was a correspondingly better chance for primary union. It is also noticed that, with a shortened distance from trochanter to ilium, as would occur with greater destruction, from an operative standpoint there would be a better chance of securing a good bone graft between the two points. It is also noticed that the less the mobility at the time of operation the greater are the chances of a primary successful result. These factors all work together in influencing a favorable result,—that is, greater destruction, less distance to be bridged, and greater fixation.

Also, as pointed out in Table I, the longer the duration the better are the chances of success, which is in accord with the other findings,—namely, the more the destruction the greater the tendency to fixation.

The presence of a sinus or abscess at the time of operation, or the encountering of tuberculous material, did not hinder the possibility of a primary success. This must not be interpreted as a desirable condition to have present, but the presence or encountering of tuberculous material does not necessarily spell disaster. In general, it is best to carry out the



FIG. 1

Type of lesion in which prognosis is good for primary fusion. Notice the marked destruction of the head and acetabulum and the short distance from the trochanter to the side of the ilium.

primary principles of this particular operation and avoid, wherever possible, the invasion of the diseased area.

The more rapidly and acutely the disease is progressing, the greater are the chances of primary failure. In other words, the more chronic the process the greater are the chances of obtaining a successful result.



FIG. 2

Primary fusion obtained in the marked destructive lesion.



TABLE IV  
SINUS, ABSCESS, AND TUBERCULOUS MATERIAL AT OPERATION

	Sinus at Operation	Abscess at Operation	Tuberculous Material at Time of Operation
Primary . . . . .	12 per cent.	12 per cent.	27 per cent.
Secondary . . . . .	14 per cent.	10 per cent.	20 per cent.

There appears to be no advantage of the pedicle iliac graft over the free iliac graft. The removal of the cartilage from the trochanter did not increase the chances of primary successful operation. The application of a double plaster spica did not prevent the failures. In fact there were fewer primary successes when a double spica was applied.

#### SUMMARY ON CAUSE OF PRIMARY FAILURES

The longer the duration, the slower the progress, and the more chronic the disease, the greater are the chances of a primary successful extra-articular arthrodesis.



FIG 3

Type of lesion in which the prognosis is for primary failure. Notice the long distance from trochanter to ilium and relatively well preserved outline of the head.



Fig. 4

Fracture and non-union of the extra-articular bone graft.



Fig. 5

Secondary successful result after supplementary graft operation.

TABLE V  
ACTIVITY OF THE DISEASE

	Rapid	Slow	Acute	Chronic
Primary.....	20 per cent.	80 per cent.	26 per cent.	74 per cent.
Secondary.....	40 per cent.	60 per cent.	30 per cent.	70 per cent.

The greater the destruction of the head and involvement of the acetabulum and, necessarily, a closer approximation of trochanter to the side of the ilium, the more the likelihood of obtaining a primary successful result (Figs. 1 and 2). The greater the destruction, the longer the duration, and the more chronic the process, the easier will be the operative procedure, and the more certain the securing of a fusion by the first operation.

TABLE VI  
FACTORS CONNECTED WITH THE OPERATION

	Free Iliac Graft	Pedicle Iliac Graft	Cartilage Removed from Trochanter at Operation	Cartilage Not Removed from Trochanter
Primary success....	66 per cent.	34 per cent.	24 per cent.	76 per cent.
Secondary success..	55 per cent.	45 per cent.	20 per cent.	80 per cent.

	Single Spica After Operation	Double Spica After Operation
Primary success....	80 per cent.	20 per cent.
Secondary success..	55 per cent.	45 per cent.

The more the mobility, the less the chances of fixation. In the early acute cases the mobility is greater and it is technically more difficult to secure fixation while the extra-articular graft is uniting at its ends. The long leverage arm of the extremity puts a severe strain on the grafted area when there is mobility at the time of operation and reduces the possibility of union (Figs. 3, 4, and 5).

The presence of a sinus, an abscess, or the encountering of tuberculous material during the operation did not seem to be a causative factor for primary failures. It is preferable, however, to work in a clean field and uphold the primary principles of the extra-articular method. The removal of the cartilage from the trochanter or the application of a double plaster spica did not reduce the number of primary failures.

#### CONCLUSIONS

1. The extra-articular-graft method for fixation in tuberculosis of the hip joint in children is a definite, curative, operative procedure and reduces markedly the time of treatment.

2. In the primary successful cases, the patients were able to walk unaided one and one-third years after operation, although the average duration of the disease before operation was nearly five years.

3. The longest lapse of time since operation in this series is eight years. There is every indication of permanent cure in this and the other cases of the series.

4. Successful results may be obtained even though a sinus or abscess is present at the time of operation, but a clean field is preferable.

5. Forty per cent. of the patients required more than one operation before successful result was obtained.

6. The failure of the primary operation was found in the acute cases of short duration, in which there was little destruction of the head and involvement of the acetabulum, adduction deformity, and considerable free movement in the joint at the time of the operation.

7. In those cases where a primary failure may be anticipated, it is recommended that a supplementary osteoperiosteal graft from the tibia or upper end of the femur be used in conjunction with the graft from the ilium.

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# CONTRIBUTION TO THE QUESTION OF SPINAL FUSION IN TUBERCULOUS SPONDYLITIS IN CHILDHOOD\*

BY ERNST FREUND, M.D., VIENNA, AUSTRIA

*Fellow, Brown Orthopaedic Research Fellowship, Hospital for Joint Diseases, New York City*

In spite of the fact that the operative treatment of tuberculous spondylitis by spinal fusion has been practised for more than twenty years, there is still lack of unanimity in regard to the indications and to the therapeutic value of the operation. A questionnaire circulated recently among seventy-six German orthopaedic surgeons showed that eight only were favorable to the method, thirty-eight used it very seldom and only in carefully selected cases, while thirteen declared themselves as distinct opponents, and seventeen remained indifferent.

The American orthopaedic surgeons are much more receptive to the merit of the operative method, although even in this country great differences prevail regarding indications and therapeutic effect. Sorrel, who has an unusual wealth of material at his disposal, states that only three out of 802 children were operated on. On the other hand, 300 out of his 703 adult cases were subjected to the operation. Even Putti remains critical of the operation; he uses it rarely and only in adults, while Galeazzi has completely rejected the operative method.

The object of this article is to contribute from the material of the Hospital for Joint Diseases an analysis of cases of tuberculous spondylitis in children, treated both conservatively and operatively. The sixty-bed Country Home at the seashore, twenty-five miles from the city, offered a splendid opportunity for combining non-surgical and surgical care and for observation of cases during long intervals. In the selection of the material and its assignment to one or the other group, an endeavor was made to provide the greatest possible similarity of skeletal lesions and localization, as well as of the age of the patient, both for the conservatively and for the surgically treated cases. Because of these restrictions in the selection of the cases, which is materially accentuated by the great variability of the syndrome and the very strong individual differences, only a limited number of cases can be reported. On the other hand, the seclusion of the Country Home afforded the advantage of a thorough and fairly long continued investigation. We have, therefore, omitted all cases, both juvenile and adult, which had received only ambulatory conservative treatment, particularly since, according to prevailing use, such treatment is considered as merely a palliative measure which is necessitated by social conditions. The value of this institutional general treatment of bone tuberculosis, as carried out in a country home or sanatorium is already too firmly established to be discussed; although it may be that in individual cases, especially in children, a good result may

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be obtained by ambulatory treatment alone. But this is certainly an exception and, in the light of the prevailing and accepted principle, it is far from being the ideal treatment of skeletal tuberculosis.

Taking in consideration first the question of mortality, we find that the statistics of Hibbs and Risser upon 286 cases, which were almost all subjected to early operation, give the mortality rate of twenty-six and two-tenths per cent. during a period of observation covering five years or more. All the deaths were due to disease and not to operation.

In a smaller series of cases of Janik (Clinic of Lwów, Lemberg), covering eight years, from 1920 to 1928, a mortality of thirty-one per cent. in operated cases was found.

Upon first glance, this seems to exceed the mortality rate given by the best known adherents of conservative methods (Kisch, Rollier, and others). However, it should be taken into consideration that their statistics are based merely upon the condition of the patient upon discharge or while still an inmate of the institution.

If we calculate the mortality figures of conservative treatment on the basis of the long observation which was applied for the operative cases, we find that the mortality of operated cases is not so far below that of cases treated conservatively. A close comparison of these mortality figures then will show that the Hibbs or Albee spinal fusions are not representing any specific therapy for spinal tuberculosis; they claim a still higher percentage of victims than do the conservative methods.

It is far more difficult to pass judgment upon the question of biological cure, particularly upon the basis of statistics alone. The five-year interval of observation is not a sufficient criterion for proclaiming an absolute clinical cure and cases of recurrence after many years are by no means uncommon. Therefore, instead of drawing in for comparison the percentages of cures as found in statistics of conservative treatment, it seems to us more reliable to use our own cases as a basis for comparative statistics.

Eliminating all cases which had only a transitory stay at the Hospital or the Country Home and consequently no sufficient treatment or observation, there remain for the purpose of our investigation forty juvenile cases.

Of these forty cases, twelve were treated purely conservatively and twenty-eight were operated upon.

Of the twelve conservatively treated cases, five died and seven are still under treatment at the Country Home. None of these seven has as yet been discharged as cured. This apparent discrepancy in the comparison of the material is explained by the fact that the greater part of the conservatively treated cases at the Home are ultimately being transferred to the surgical group. Their average stay at the Country Home is three years.

The clinical condition of these seven cases is as follows: Two are in very good condition, showing roentgenographically good bony union in the destroyed vertebrae and relatively slight gibbosity. These cases can be

considered as healed, both from the clinical and roentgenographic points of view.

Five cases are in good condition, showing a clinical manifestation of healing. In the x-ray, however, there is no solid union in the vertebral débris. Of these patients, two are up and about in a plaster jacket; while one, with a dorsal lesion, is recumbent in a Calot jacket; and two cases are on frame with traction. We believe that the prognosis is favorable for all these cases, even though four of them show a marked gibbus.

These seven cases demonstrate, in spite of their small number, that it is possible that Pott's disease may be healed in childhood under entirely conservative measures. They also demonstrate that if more than one vertebra is attacked, which is very often the case, a very long time is consumed to effect complete healing. In all of these cases more than one vertebra was involved; in one case with a dorsal lesion, five vertebrae. Even with early and proper treatment and in the absence of sinus formation, one must figure on an average of at least four years of conservative treatment. The question, of course, arises whether it is possible to keep a child in an institution for that length of time, or whether it is not possible to release these cases from institutional care at least for a considerable period of their disease. When we follow carefully the course of the seven cases mentioned, as well as that of the cases operated on after a long period of conservative treatment, the impression is gained that spondylitis remains stationary for a long period of the disease. That occurs when maximum bone destruction has taken place and obvious signs of healing appear in the x-ray picture; in other words, the bone structure becomes more clearly and better defined. At this period new bone is formed, but this process is very slow and the complete formation of the blocking piece of bone, which occupies the site of the destroyed vertebrae, requires years. Apparently hospitalization, even in the best institutions, is not able to effect this, and it is argued that some cases, after a long drawn-out rest, require a change in surroundings in order to bring about final healing at the same rate of progress as observed during the more active stage of the disease. Whereas, in the more active stage, the predominant signs of the exudative type of spondylitis gradually are seen to yield to the productive type (as already described by the writer in a former publication from the Istituto Rizzoli); afterwards, the process of healing seems to remain at a dead level. For such cases, provided they are not complicated by cord compression, an interruption of the rest cure by application of a plaster-of-Paris cast and tentative discharge from the institution may be beneficial. Putti and Vacchelli reporting from the Alpine Sanatorium of Cortina di Ampezzo, emphasize this fact, and insist upon patients being removed from the institution from time to time, and advocate particularly the change from Alpine to maritime surroundings.

It was mentioned that four out of the seven cases treated conservatively showed marked deformity. This also applies to some of the surgical cases which had been treated on a frame before operation and

which showed a considerable increase in the kyphosis. In all of these cases attempted corrections of the deformity were uniformly unsuccessful with the exception of a single case which was treated on the frame with felt padding under the gibbosity. In this latter case the tracing of the deformity showed unmistakable though not very considerable correction of the angulation. This fact is emphasized because it proves that correction of spondylitic gibbus is indeed possible in recumbency. Finck has treated a large number of cases in which the gibbosity was successfully improved or entirely corrected by this method of gradually increasing pressure by means of cotton padding placed under the deformity in the reclination bed of Lorenz. Waldenström also, making use of the same method, gives some striking results of correction of the deformity or improvement in eighty per cent. of the cases. Finck takes his idea from the Calot method of redressment force of the spine; although he does not actually use this method, the principle of which has met with serious objections from all sides. As a matter of fact, it seems that the correction is more apparent than real, inasmuch as the process observed in the spine, in response to the slowly increasing pressure, develops compensatory curves above and below the diseased area, to which may be added the atrophy of the prominent vertebral processes.

We must say one word in regard to the five fatal cases in our series of twelve conservatively treated. This may, at first, be a strikingly high figure, but it becomes readily understandable if we consider that these cases, because of their poor general condition, were not taken into the group of surgical cases. Two of these latter cases showed double lesions,—that is, a spondylitis and fungus of the foot with cold abscess and sinuses; and a spondylitis with caries of the frontal bone. These patients also had pulmonary tuberculosis. In three other cases there were abscesses with amyloidosis and general sepsis; one of these showed a paralysis of the lower extremity, the other a severe degree of ascites due to general amyloidosis and weakness of the heart. Cases with double lesions took a very malignant course from the onset.

#### OPERATIVE GROUP

The operative group may be divided into two groups: those operated on early,—that is, those in whom the spinal fusion was carried out in the first year of the disease; and those operated on late,—that is, those in whom the spondylitis existed clinically for at least one year and the operation had been preceded by conservative measures.

The first group embraces nine cases; the second group nineteen. This ratio clearly indicates that the policy of the Hospital for Joint Diseases is to treat children with Pott's disease conservatively at first; the surgical steps follow upon the completion of the conservative treatment.

In regard to the age, the patients operated upon early varied from three to thirteen years,—average, six years of age. All but one remaining



in the Country Home had conservative after-treatment for a period ranging from one to eight years.

Of these cases operated on early, two died; one, one year and the other four years after operation.

It seems that the operation can not be brought into a causal relationship with the fatal issue, and we must consider the operation as almost absolutely safe. One of these two patients died of amyloidosis of the viscera after the postoperative appearance of numerous abscesses and sinuses; in the other case the operative field became infected with tuberculosis, the graft became necrotic, partially extruded, and death ensued as the result of miliary tuberculosis.

A survey of the results in the remaining cases operated on early was as follows:

In one case the result was excellent. In this case, however, we believe that the prompt cure was independent of the operation and that it was due to the rather infrequent fact that only one vertebra was attacked. Of this, only half of the vertebra was destroyed and the adjacent intervertebral disc was not involved. Healing took place without deformity and with complete normal function of the vertebral column, as a control examination showed six years after the operation. At that time, the graft had completely disappeared.

The remaining six cases, following operation, showed a considerable increase of the deformity as a result of further destruction of the vertebrae, with the exception of two cases in which too short a period has elapsed to make a reliable statement in this regard. In one case there appeared paralytic manifestations of the lower extremity, of the bladder, and of the rectum immediately after the operation, which persisted for two and one-half years, in spite of the fact that the patient was lying comfortably on a frame with both of his legs in traction. In another case the bone graft turned out to be too short because of subsequent expansion of the caries, so that a second Albee operation had to be performed to fix the whole diseased spine.

Summarizing these nine cases operated on early, the impression was that the Albee operation performed early in the disease is not likely to shorten the course of the disease or to lessen its severity. It seems that the spinal tuberculosis of childhood will, in spite of operation, pursue its course, and that it sometimes will extend beyond the section of the spine which had been fused. The graft in the still active vertebral process is altogether unable to prevent the appearance or the increase in deformity after operation. It would seem, therefore, that, since sufficient immobilization can be obtained by means of the frame or the plaster bed, there is no reason for undertaking the operation in the early stage of Pott's disease.

#### LATE CASES

It now remains to consider these conclusions with reference to the two

teen cases, from four to sixteen years of age. The operation was carried out on an average of four years after the onset of illness. Nine of these operations were performed after a more or less continuous conservative treatment in other institutions. The remaining ten cases entered the institution while the process was still active and remained there for a period of from eight months to three years, on an average of two years before operation was performed. All cases were sent back to the Country Home for after-treatment. Three of the ten are about to be discharged, while the other seven have remained from eight months to two and one-half years—an average of sixteen months—after the operation. Therefore, of the nineteen cases operated on late, twelve cases have been discharged and seven are still at the Home. Of these remaining seven cases, one is in utterly hopeless condition because of complete paralysis and extreme deformity, both existing before the operation. Two show very good results, while the four others are still too recent to be classified.

The results of the twelve cases which have already been discharged can be classified as altogether good. In seven cases, cure was effected with little or no deformity and the result was excellent. In six of these, the lesion was in the lumbar spine. Of the five remaining, four show considerable kyphosis; three of them are still wearing a light corset. The whole period of postoperative observation varies from two to six and one-half years,—an average of three years.

The data regarding duration of conservative preoperative and postoperative treatment in surgical cases show that the operation is to be considered only as a link in the chain of various measures and has, in the whole plan of treatment, essentially no greater importance than the associated procedures.

We have already mentioned the fact that in our early cases the graft was unable to hinder the appearance or the future development of the deformity, and that even in three of the cases operated on late there was a postoperative increase of the deformity, though a slight one. We may say, therefore, that the graft does not represent a purely mechanical support of the vertebral column with the action of a ramrod, which was attributed to it by the original conception (due to the influence of Lange's idea of using celluloid staves). Mention is made of this because this view is still altogether too prominent.

On the contrary, the bony tissue undergoes a continuous rebuilding as it does in other bone transplants in the body. The graft dies almost entirely and is slowly being absorbed and replaced by new bone tissue upon which mechanic and static factors subsequently become operative. According to the writings of Dubois pressure is of far greater significance for the maintenance of the bony structures than tension, and the latter rather tends to promote absorption if in excess of a certain physiological maximum. In the x-ray picture, consequently, we see areas of clarification, sometimes even as transverse fissures, and this lack of continuity is often mistaken for fractures. They represent essentially the same forma-

tions as are sometimes observed in extra-articular arthrodesis of the hip, especially when this operation has been performed in too early a stage so that joint destruction with adduction deformity takes place. In fusion of the hip joint, for instance, the bone graft, if placed at early stages of the disease, is unable to prevent the appearance of the adduction deformity, and the tension continually exerted upon the graft by the contracting capsule and muscles on the inner side of the joint brings about a pseudarthrosis in this area of resorption (*Umbauzone*). The bone graft in operations upon the spine is still considerably weaker than the graft used for arthrodesis of the hip, and therefore much less able to prevent deformity by its own strength. The earlier the operation is carried out in a case of destructive spondylitis, the less is the possibility of preventing the deformity, since the continuing vertebral caries leading to a mutual approach of healthy bone processes after collapse of the necrotic area, in combination with the contractures of the anterior vertebral structure, subject the graft to forces of tension of an unphysiological degree, such as living and extremely plastic bone is not able to resist. So we see the tissue becoming absorbed at the point of the severest tensile stress and zones of osteoblastic activity develop known as "Looser's *Umbauzonen*" with formation of a pseudarthrosis. This usually lies directly over the gibbus at the transition point between the diseased, relatively less movable, and the healthy, comparatively more movable section of the vertebral column. In our material of fifteen cases these zones of clarification could be clearly seen, and, therefore, we feel that the fear expressed by some authors, that the bone graft might interfere with the collapse of the destroyed vertebrae and the subsequent solidification usually necessary to produce satisfactory healing of tuberculous spondylitis, is without grounds.

Conversely, it has been maintained that, if the deformity can increase after operation, the graft is useless as a support for immobilization of the diseased spine. It seems that in the decision on this point lies the whole basis for the indication of operative stabilization of the spine in tuberculosis.

As already mentioned, the circumscribed areas of absorption, forming a pseudarthrosis, are known as "*Umbauzonen*". We find that this area is composed of connective tissue, often with cartilage and calcium-free or osteoid bone. It is strong enough to bring about sufficient immobilization of the diseased part of the spine for practical and clinical purposes and it represents much better fixation than a corset. When we reoperate on these cases, as is frequently done, we see that, in spite of the lack of calcified bone tissue, the spinous processes are firmly fixed to each other, while those above and below the operative field are freely movable. We, therefore, believe that the argument that zones of rarefaction will appear, particularly in the neighborhood of the graft, is not a sufficient reason to doubt the validity of the bone graft. On the other hand, we see that in the course of the physiological changes of bone structure occur, ending in

the complete and permanent resorption of the transplanted graft which has been observed in two of our cases with perfect functional result. We might feel, therefore, that in cases of slight involvement of the vertebrae, in which the intervertebral disc is not involved, the function of the graft would be doubtful. Experiments of Walter Müller seem to prove that no normal joint could be successfully fixed by bone graft, placed extra-articularly. It is from this point of view that we might find an argument against Albee's method in mild tuberculous caries, as this is entirely an extra-articular method.

In cases of dorsal Pott's disease, the graft often undergoes such changes that a mere narrow strip of bone remains, binding together the tips of the spinous processes and corresponding exactly to the ossification of the supraspinatus ligament. In the lumbar spine, on the contrary, there is often found at the conclusion of the rebuilding an obvious increase in the thickness of the transplant, palpable even through the skin as a large bony mass. It seems, therefore, that the lumbar region appears more suitable for the Albee operation than the dorsal region. The graft here evidently is subjected to a greater functional demand under the influence of which it hypertrophies. Absorption at the border of the lumbosacral region, however, seems to be the rule. This, too, shows how greatly dependent the graft is upon the movability of the neighboring joints, which is certainly greater in the lumbosacral articulation than in the intervertebral joints of the spine above. On these grounds, it seems that the Hibbs method of spinal fusion with operative destruction of the small joints of the vertebrae, if exactly carried out, would be superior to the Albee technique.

In conclusion, we would like to mention a series of postoperative complications. Here belong the appearance of psoas abscesses, sinuses, and paralysis, so often encountered following the operation, especially when it has been carried out in the early stage. These are naturally not referable to the operation itself and merely show that spondylitis in these cases follows its natural course unhindered by the operation. The later the operation is performed,—that is, the farther the vertebral disease is on the way to healing, the rarer are these complications.

Of greater importance is the appearance of abscesses and sinuses in the operative field, as occurred in three of our cases.

It is also worth mentioning that among our twenty-eight cases operated upon there were four postoperative fractures of the tibia at the site of the removal of the graft. In three cases the fracture developed upon the operating table during the removal of the graft, and in one case ten months later after a slight trauma. In three cases the fracture healed perfectly without complications; however, in one case there was a double fracture which led to pseudarthrosis for which a new operation with transplantation of a bone graft from the other tibia was necessary.

The most serious complication was the sudden appearance of post-operative paralytic ileus in a case of lumbar spondylitis. Here, ileostomy

had to be performed and the patient ultimately recovered. In this case also it was found that the cerebrospinal fluid, recovered during the lumbar anaesthesia at the time of the ileus operation, was positive in the guinea pig for tuberculosis. This shows that an external pachymeningitis may be associated with spondylitis, and tubercle bacilli may appear in the fluid without any clinical signs of tuberculous meningitis.

#### CONCLUSIONS

The most important results of this investigation may be summarized as follows: Pott's disease in childhood is very well capable of healing under purely conservative measures. The average duration of the healing process in a sanatorium is at least four years. The Albee operation, when undertaken in an early stage, is unable to protect the vertebral column against deformity. With increasing destruction of the vertebrae, the tibial graft undergoes marked changes with circumscribed resorption, usually immediately over the gibbus. Being plastic bone tissue, it is bent out of shape. It, therefore, appears useless to undertake the operation upon children in the early stage. The facts that at this time it is impossible by the means of the roentgenograms to say anything definite regarding the extension of the vertebral tuberculosis, and that at the time of operation vertebrae which appear roentgenographically normal and which are not included in the region of fusion may be diseased, these facts, likewise, speak against operation in the early stage.

In the late cases in which the spondylitis is already on the way to healing or is already healed as a result of conservative measures, the problem is different. In such cases, the graft may contribute considerably to the stabilization of the defective spine, especially in the lumbar region, and to the assurance of maintaining the result already reached. Following the necrotic process, subluxations in the intervertebral joints certainly result from the dislocation of the body fragments. This, no doubt, leads to seriously altered statics in the whole vertebral column and to manifestations of insufficiency of the muscular and ligamentous apparatus with pain. We must admit, however, that the juvenile organism is able to adjust itself to even a very severe deformity over a very long period of time. Ultimately, however, increasing manifestations of fatigue appear. These are often interpreted as indications of recurrence of the tuberculous inflammation, whereas they are as a matter of fact merely signs of static insufficiency. In such cases, operation seems to be indicated. It is in these cases, however, merely symptomatic and not directed against the disease itself. Our material, although rather limited, seems to indicate that, even before the onset of static insufficiency of the spine, the spinal fusion may be effective immediately after the conclusion of conservative treatment. It is perhaps, as a new stimulus, capable of forcing the organism into the last stage of healing, which is usually somewhat protracted, and so of bringing about somewhat more rapidly bony union of the vertebral

fragments. The observations of Waldenström and Johansson seem to point in this same direction.

The writer wishes to acknowledge his gratitude for the generous permission to use the material of the Hospital for Joint Diseases.

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## RESTORATION OF THE DIGITAL PORTION OF A FLEXOR TENDON AND SHEATH IN THE HAND

BY MATHER CLEVELAND, M.D., NEW YORK, N. Y.

The difficulty of restoring a lost flexor tendon in a finger is well recognized by every surgeon who has attempted it. For success in plastic surgery of this type certain conditions are requisite. The skin and subcutaneous tissue of the finger should be in good condition, freely movable, not bound by adherent scar to the phalanges. Starting at this point the surgeon must introduce a new tendon with an adequate gliding mechanism and restraining band or vinculum at the joints to keep the tendon from bow-stringing. Primary union and early, carefully controlled, active motion are essential to regain function. In my experience a great majority of the patients who have lost a tendon in a finger have stiff fingers with adherent scars, and failure or only partial success has attended any surgical attempt to restore the tendon.

In March, 1931, a girl of eighteen applied at the New York Orthopaedic Dispensary, complaining of a deformity of her right middle finger, which followed an infection five years previously. This infection began as a furuncle at the distal flexion crease, which was incised inadequately, and within a few days the entire hand was swollen and acutely painful. She entered a hospital near her home, where a second operation was performed. An incision was made in the proximal closed space and another over the palmar portion of the tendon sheath of the right middle finger. Both of these incisions were in the long axis of the tendon sheath. The wounds drained for about two weeks and no sloughing of the tendons occurred. Since the operation there has been complete inability to flex the finger.

Physical examination showed no active flexion in the proximal or distal interphalangeal joints of the right middle finger, but free passive motion. The middle phalanx was pulled into hyperextension by the lumbricalis and interossei. This deformity was most distressing to the patient and made her reluctant to shake hands. The skin and subcutaneous tissue were in good condition. It was impossible to determine whether the tendons had been divided and retracted, or destroyed by infection, but it was decided that a repair should be attempted.

*Operation June 16, 1930, Case 127,361, New York Orthopaedic Hospital.* Under a blood-pressure-cuff tourniquet, released at thirty-minute intervals, a transverse incision was made in the distal flexion crease of the right middle finger toward the ulnar border of the finger, then continued anterolaterally to the proximal flexion crease, then transversely along this crease to the middle of the finger and proximally into the palm. This single incision exposed the entire digital portion of the finger and the adjacent palm. The profundus tendon insertion remained as a tiny stump, about one and five-tenths centimeters long, attached to the distal phalanx. Proximal to this no tendon or sheath could be seen until the middle of the palm was reached, and there the proximal ends of the flexor sublimis and profundus tendons were found bound down by scar tissue. The sublimis tendon and a delicate sheath surrounding it were freed and excised, making a free graft eight to ten centimeters long (Fig. 1). This was sutured to the distal and proximal stumps of the flexor digitorum profundus (Fig. 2). A strip of fascia lata was excised from the thigh and folded around the reconstructed tendon with its gliding or smooth surface adjacent to the tendon. At each of the joints a small strip of fascia lata

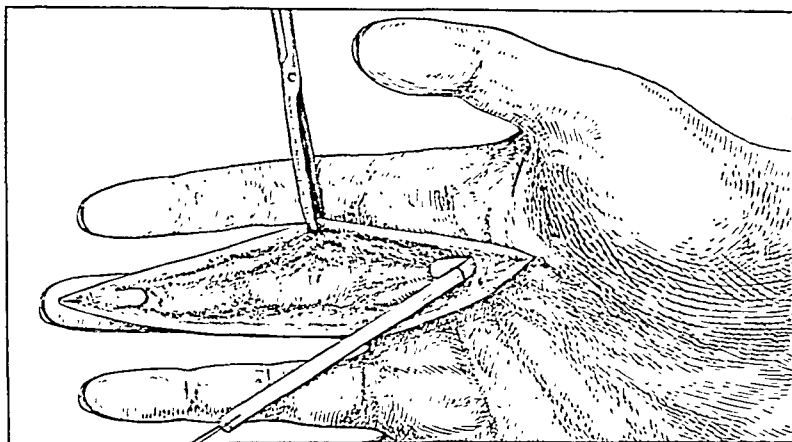


FIG. 1

Shows the exposure of the finger and palm, with the stump of the profundus tendon attached to the distal phalanx. The sublimis tendon has been freed in the palm and is drawn out into the wound and divided to form the free tendon graft. (The skin incision in the drawings is schematic.)

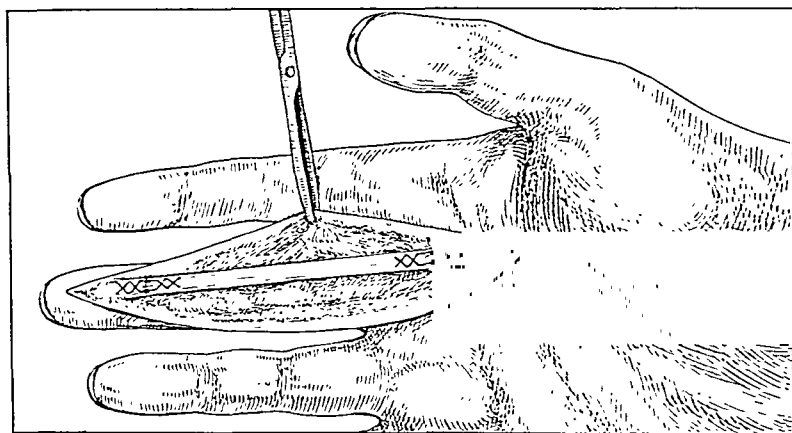


FIG. 2

Shows the sublimis tendon graft sutured to the distal and proximal profundus tendon stumps.

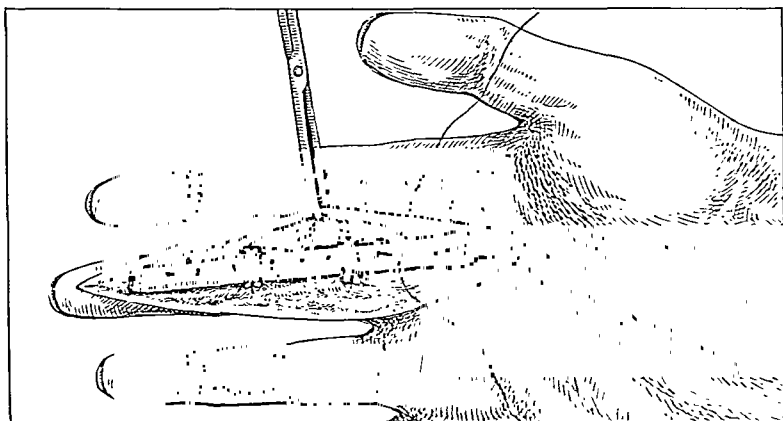


FIG. 3

Shows the fascia lata sheath around the new tendon with the vincula of





FIG. 4

Shows end result two and a half years after operation.

was drawn over the tendon and its sheath and sutured to the periosteum and scar tissue on each side. The strips were intended to serve as vincula (Fig. 3). Fine interrupted silk sutures were used throughout. The subcutaneous tissues were closed with plain catgut, and skin with dermal, all interrupted. The finger was held in flexion with an elastic band and the patient was instructed to extend the finger actively against this elastic pull, beginning the first postoperative day. She left the hospital on the twelfth day after operation with her wounds healed and a fair range of motion in the finger.

Apparently the tendons had been divided in the previous operative procedure and the sheath had been obliterated by the infection.

At the most recent examination, December 27, 1932, two and one-half years after operation, the patient was found to have a useful hand and finger. She is delighted with the result which is shown by the photographs taken on this date. The right middle finger is held flexed twenty degrees at the proximal interphalangeal joint and forty degrees at the distal interphalangeal joint. Active motion in the various joints of the finger is present as follows:

Metacarpophalangeal joint:

Extension to 180 degrees	} Full range
Flexion to 90 degrees	

Proximal interphalangeal joint:

Extension to 160 degrees	} Lacking 20 degrees of the full range. Seventy-seven per cent. complete.
Flexion to 90 degrees	

Distal interphalangeal joint:

Extension to 140 degrees	} Only 20 degrees of motion or about thirty per cent. of average total.
Flexion to 120 degrees	

There is a very slight tendency for the tendon to bow-string from the metacarpophalangeal joint to the distal interphalangeal joint.

The large measure of success in this procedure was probably due to the following factors which are sufficiently important to repeat:

1. The excellent condition of the skin and subcutaneous tissue.
2. The free motion in the interphalangeal joints.
3. The introduction of an adequate gliding mechanism around the new tendon.
4. The placing of vincula at the interphalangeal joints to prevent bow-stringing.
5. Early active motion.

## OS SUBTIBIALE

### INCONSTANT BONE OVER THE TIP OF THE MEDIAL MALLEOLUS \*

BY PAUL W. LAPIDUS, M.D., NEW YORK, N. Y.

*Assistant Adjunct, Hospital for Joint Diseases;  
Assistant Surgeon, Hospital for Ruptured and Crippled*

The very unusual findings and the extreme rarity of the condition observed in the cases reported below make it worthy of a permanent record in print.

CASE 1. L. P. (C-3357), white, a plumber, twenty-three years of age, was seen by the writer in the Foot Department of the Hospital for Joint Diseases on February 27, 1931. The patient complained of pain over the right medial malleolus, following a sprain about three months previous to the admission. He also gave history of spraining the right ankle in eversion about eight years ago (at the age of fifteen). After the first injury there was swelling and ecchymosis around the right medial malleolus. The patient remained in bed during the first day and walked with a slight limp for a few days thereafter. Following that he had no discomfort, but noticed that his right medial malleolus gradually became more prominent than the left.

Examination revealed that the patient was a young man in apparently good general health. There was moderate outward bowing of both tibiae with marked compensatory pronation of both feet (Fig. 2). The forefeet were slightly abducted, with longitudinal arches fairly well preserved. The right medial malleolus (Fig. 1) appeared unusually prominent, but it was not at all tender. Motion in all joints of the feet was perfectly free and painless, and the pulsation of the feet arteries was good.

The roentgenogram of the right ankle (Fig. 3) was reported by Dr. M. Pomeranz as "Ununited epiphysis—internal malleolus, right ankle".

A tentative diagnosis of ununited epiphyseal separation of an inconstant epiphysis of the medial malleolus was made.

The roentgenogram of the opposite ankle, taken at a later date, also showed the presence of a similar ossicle, symmetrically located over the tip of the left medial malleolus (Fig. 3). This ossicle, however, was much smaller than the one on the right side, and it showed less calcification. The right ossicle measured twenty by nine millimeters; the left, twelve by six millimeters. Each was connected with the medial malleolus along its longer dimension in oblique plane to the long axis of the tibia. The right medial malleolus correspondingly was much wider than the left, the right measuring twenty-one millimeters and the left twelve millimeters.

The patient was admitted to the hospital and the prominent part of the right medial malleolus was removed.

The specimen was reported by Dr. H. Jaffe as consisting of "a small fragment of bone showing nothing unusual on macroscopic examination. Sections showed two fragments of rather compact bone separated by fiber bone containing numerous Sharpey fibers."

It is evident that we had in the above described patient a case of rare variation of ankle skeleton where the trauma had caused slight changes on the right side and certainly could not be considered an etiological factor.

CASE 2. M. W. (C-72-872), a white boy, nine years old, was seen in the clinic of Dr. Toufick Nicola at the Hospital for Ruptured and Crippled on March 25, 1933. The boy

\* From the service of Dr. Leo Mayer, Hospital for Joint Diseases, and Dr. Percy W. Roberts, Hospital for Ruptured and Crippled.

complained of occasional pain in the right leg for the past few months. There was no history of injury to feet or legs. The child was somewhat overweight showing evidence of endocrine disturbance. There was slight enlargement over the anterior plane of the right tibia. He also presented a moderate degree of weak feet. The medial malleoli were not unusually prominent and were not tender. The roentgenograms of the right leg showed an old cortical abscess of the tibia. Incidentally a small ossicle was found beneath the tip of the right medial malleolus. A check-up roentgenogram of the left ankle revealed a similar ossicle beneath the left medial malleolus (Fig. 4).



FIG. 1

Case 1. Close view of the right foot before the operation. Note considerable pronation and very marked prominence of the medial malleolus.

The writer is under the impression that Case 2 also presented a separate ossutibiale. However definite differentiation from an accessory center of ossification in the tip of the medial malleolus will be possible only in the future, providing the ossicle still remains separate by the time of disappearance of the lower tibial epiphysis.

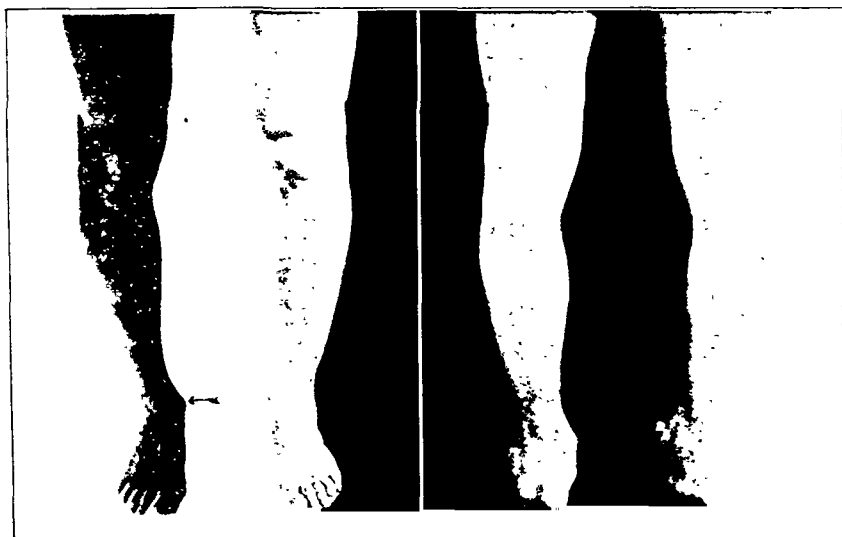


FIG. 2

Case 1. Appearance of both legs and feet (after the operation). Moderate outward bowing of legs with compensatory pronation of feet. Note the still present prominence of the right medial malleolus (arrow).

A review of the literature on the subject shows only a few reports of a similar condition. Pfitzner and later Bircher described this ossicle under the name of "Os Subtibiale".

Fairbank quotes Sir Arthur Keith, admitting that the latter had never met with a case and was unable to offer any morphological explanation of the condition.

Neither Holland nor Lupo, in his study of inconstant bones of feet, has ever seen a case.

Mouchet reported one case which he considered "curious" and stated that he had never found any mention of this condition in treatises of anatomy. However, Gray, describing the development of the tibia, stated that "two additional centers occasionally exist,—one for the tongue-shaped process of the upper epiphysis, which forms the tubercle, and one for the inner malleolus". Gray also said in his description of sesamoids that "sometimes sesamoids are present over the medial and lateral malleoli".

Åkerlund does not say anything about a special center of ossification

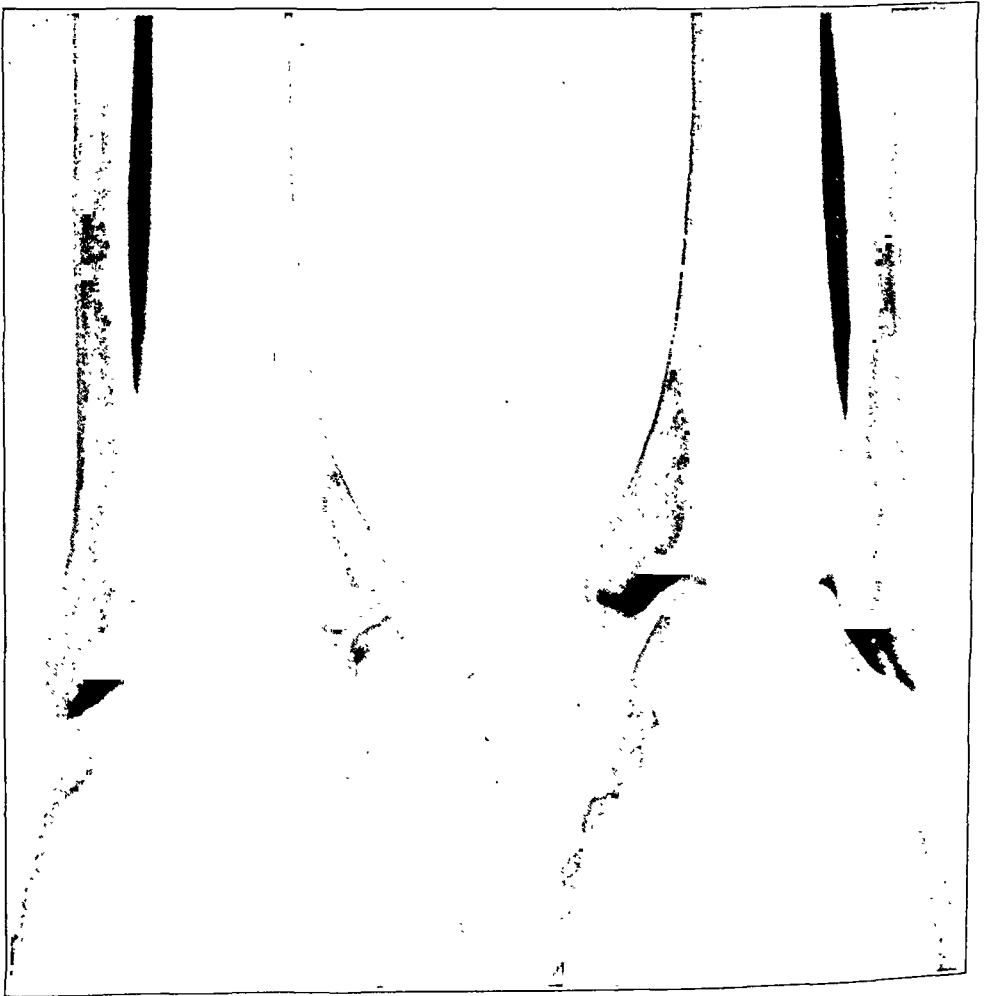


FIG. 3

Case 1. Anteroposterior view of both ankles showing bilaterally present os subtibiale. Note that the right os subtibiale is larger than the left and is more calcified. The right medial malleolus is correspondingly wider than the left.



FIG. 4

Case 2. Bilaterally present separate ossicle (arrow) in the tip of medial malleolus.

for the medial malleolus. However, his Table I, Figure 2, shows a roentgenogram of a foot in the case of a girl, eight years old, where this center is demonstrated.

In our previous report (Burman and Lapidus) of a study of 1000 feet (mostly in adults) with special reference to inconstant bones, we did not observe a single case. However, only dorsiplantar and lateral views of feet were studied, while os subtibiale is most clearly seen on anteroposterior views of the ankle, the latter not being included in our series.

On the other hand, Den Hoed in a review of roentgenograms of 150 sound children between the ages of six and fifteen, found in twenty-one cases (fourteen boys and seven girls) a separate center of ossification for the tip of the medial malleolus. Den Hoed did not examine both feet and does not know whether the condition was bilateral. He does not think it is as rare as considered by Fairbank.

It is the author's conclusion, from the analysis of previously reported cases, that there are two definite entities, which have not as yet been clearly differentiated. That might have accounted for the contradictory opinions regarding the frequency of this condition.

The first group may be classified as an inconstant center of ossification or, possibly, an epiphysis of the medial malleolus somewhat similar to the one observed over the styloid of the fifth metatarsal. The cases of

Fairbank, Den Hoed, and Mouchet, all observed in children, seem to fall in this group.

Mouchet's case of a boy twelve years old is especially illustrative. Taking three consecutive roentgenograms at six months' intervals, Mouchet found on the second roentgenogram the center of ossification over the tip of the medial malleolus considerably larger than on the first; the third roentgenogram showed complete fusion of the center with the medial malleolus. Den Hoed found the center of ossification of the medial malleolus most commonly present between eight and nine years, at which age the center of ossification was also of the largest size.

The second group of cases, all observed in adults, as Bircher's cases and the author's Case 1, are best fitted into classification of an inconstant bone,—“*os subtibiale*”. These cases are no doubt extremely rare. Accessory scaphoid, *os trigonum*, or accessory center of ossification of the adult patella, may be considered homologous with *os subtibiale*. The only definite confirmation of this point of view, considering *os subtibiale* as an inconstant bone, would be the discovery of an independent bone similarly located at the tip of the medial malleolus in some lower animals. This problem is beyond the scope of the present paper, and its solution is left to those better qualified to answer it.

Ruckensteiner demonstrated the presence of the distal tibial epiphysis as early as the seventh month of life, in any event nearly always before the second year. According to him, the distal tibial epiphysis develops in transverse direction to the long axis of the limb. As the ossification of this epiphysis reaches the medial lower edge of the tibial diaphysis, the ossification of the epiphysis continues medialward and downward, forming the medial malleolus. The latter takes place only at the age of eight or nine years. At about this time an inconstant independent center of ossification may occasionally be formed at the tip of the medial malleolus. This center seems to unite soon after its appearance. One case was seen by Ruckensteiner.

Whether the cases of accessory center of ossification of the medial malleolus and the case of *os subtibiale* are two entirely independent conditions, or related in the respect that *os subtibiale* is just an accessory center which failed to fuse to the medial malleolus, remains a moot question.

Gray's and Grashey's interpretation of *os subtibiale* as a sesamoid is mentioned only to be discarded. The writer agrees entirely with Lupo, Fairbank, and those to whom Fairbank showed his roentgenograms, that a diagnosis of sesamoid is out of the question.

The generally accepted conception of a sesamoid as a bone imbedded in a tendon running over a joint between two other bones, and having an articular facet covered with hyaline cartilage facing the joint cavity (as the patella), certainly does not agree with the features of the *os subtibiale* nor the accessory center of ossification of the medial malleolus.

## SUMMARY

Two cases of bilateral extremely rare inconstant bone, os subtibiale, are reported,—one in an adult, the other in a child.

An accessory center of ossification over the tip of the medial malleolus is occasionally observed in children, appearing around six and fusing at about thirteen years of age. This accessory center and the os subtibiale seem to be two different entities which, however, may have some relation to each other.

The writer is greatly indebted to Dr. T. Nicola for his kind permission to report Case 2, and also to Dr. R. Lewis, the Roentgenologist of the Hospital for Ruptured and Crippled, for bringing to the author's attention the very interesting roentgenogram.

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## TUBERCULOSIS AND POLIOMYELITIS \*

BY DR. E. ŽUMSHINA, KHARKOV, U. S. S. R.

*From the Clinic of Orthopaedic Surgery and Traumatology, Kharkov Medical Institute,  
Prof. S. L. Tregubow, Director*

According to statistics of orthopaedic institutions in Europe, the largest percentage of disease is that of bone and joint tuberculosis, and the second that of deformity resulting from anterior poliomyelitis. Both of these diseases are met with chiefly in early childhood, and it would be expected, considering the very large number of cases, that some would be found in which these diseases are associated. However, no mention of such a relation of conditions has been found in the Russian literature and only one reference in any foreign literature.<sup>1</sup> Recently an article was published by a Swiss physician, requesting information as to whether any observer had ever seen the combination of bone and joint tuberculosis and infantile paralysis. Such a case had never come to his attention.

During the twelve years in the Clinic of Orthopaedic Surgery and Traumatology in Kharkov, in which a large number of surgical cases in children have been treated, and through which 4,350 cases of tuberculosis and 1,407 cases of infantile paralysis have passed, there has been observed but one in which there was the undoubted coincidence of tuberculous coxitis and poliomyelitis. The rarity of the case justifies its full report.

The case is that of a boy of fourteen, of healthy parentage, well, and of good physical development, until the age of three, in 1921. Following injury to the left leg, he developed a limp, and four months later, after a repetition of the trauma, there was inability to use the leg. Treatment by a plaster-of-Paris spica was instituted, and, on removing the bandage three months later, the patient was again able to walk, but at this period the child developed an acute illness, with high temperature, and was kept in bed for six weeks, after which there was discovered paralysis of both legs. The right after a time gradually recovered; the left remained flaccid. In 1922, in the vicinity of the left hip joint, a fistula appeared, which healed after five or six months, and remained closed. The use of the right leg gradually returned, but the left has made no improvement up to the present time. A few small ulcers, which healed slowly, appeared on the sole of the left foot; otherwise, the general health of the patient has been good.

*Present condition:* Patient is somewhat backward in growth for his age,—height, 188 centimeters; weight, 30 kilograms; poorly nourished; has large lymphatic glands and shows, due to the paralysis, a distinct obliquity of the pelvis, lower on the right. The lower extremities show marked atrophy of the muscles of the left leg, eversion of the hip, genu valgum, with foot in equinus. The skin is cyanotic, with atrophic cicatrices from old ulcers; almost entire paralysis of the muscles of the hip and of the leg, with shortening of thirteen centimeters (six in the upper and seven in the lower portion); atrophy of the thigh of seven centimeters, and of the calf of six centimeters. All active movements of the left leg are absent; passive movements free. The hip joint allows motion to ninety degrees, adduction normal, abduction limited, rotation painful. The trochanter is five centimeters above Nelaton's line. The knee joint allows flexion to ninety degrees, and

\* Reported at the Scientific Section of Orthopaedic and Traumatic Surgery, March 27, 1932.

full extension. There is motion in the ankle joint,—dorsal flexion to 120 degrees, plantar flexion normal; reflexes are absent.

In the right leg, the most notable changes are in the region of the sole of the foot; foot is in pes calcaneus and cavus; toes in dorsal flexion; general atony of the muscles; reflexes are slow; sensation normal.

The roentgenogram in April 1932 (Fig. 2) showed pathological changes,—an upward dislocation of the hip; the acetabulum widened and deformed; the trochanter major resting on the os ilium; the head of the femur absent; remains of the neck somewhat pointed and extending into the acetabulum; very slight reparative changes. General examination of the urine and blood was practically negative. The von Pirquet reaction was positive; Wassermann negative.

The electric tests for muscles showed complete loss of response to galvanic and faradic currents on the left. The right leg, in tests to electric excitability, showed R-0.8, A-2.5, indicating a small elevation of excitability.

Attention is called to some of the peculiarities of this case,—namely, the absence of contraction in tuberculous coxitis; the marked degree of motion in the joint (passive flexion to ninety degrees): and the extreme degree of shortening of the leg (thirteen centimeters).

The condition evidently indicates a tuberculous coxitis, with marked destructive changes, together with the residuum of an infantile paralysis.

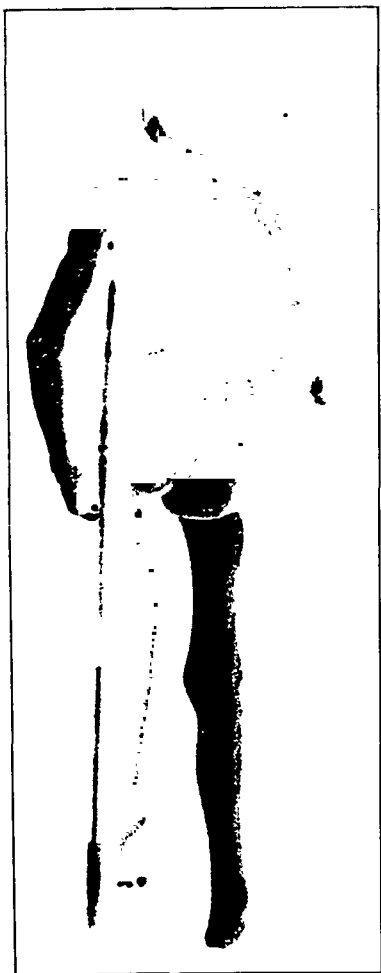


FIG 1



FIG. 2

It has always been a point of interest that the association of joint tuberculosis and poliomyelitis is so seldom observed. The diagnosis of neglected cases, so often met with, does not present difficulties, and the recognition of these conditions should not be difficult, and errors should not be so frequent as, for instance, with lues of the bone. The explanation of this rarity of occurrence is difficult; it is a question whether those individuals having suffered from poliomyelitis have some biological immunizing properties in regard to tuberculosis, and *vice versa*. Moreover, there arises the question as to why poliomyelitis is not met with in combination with osteomyelitis, also often found in children, but seldom in children who have suffered from poliomyelitis, and who, therefore, having atrophied bones, would seem to be more susceptible to trauma and would give a greater percentage of such hybrid cases. However, such combinations have not been observed by us.

1. LAMY, L.: The Antinomy of Tuberculosis and Infantile Paralysis. J. Bone and Joint Surg., XI, 542, July 1929.

## ISOLATED FRACTURES OF THE OS MAGNUM AND TRAPEZIUM

EARLE I. GREENE, M.D., F.A.C.S., AND LEO FREDERICK MILLER, M.D.,  
CHICAGO, ILLINOIS

Fracture of a single carpal bone, with perhaps the scaphoid as an exception, is a condition worthy of recording. It is important to make an early and accurate diagnosis in all lesions of the wrist, for upon this early knowledge of the exact pathology depends often the ultimate condition of the wrist. If, however, more of these injured wrists are given the benefit of a very thorough and critical roentgenographic study, more of these isolated bony fractures will be recognized and appropriate treatment instituted. A review of the literature reveals twenty-four isolated fractures of the os magnum, and but twenty fractures limited to the trapezium.

Fractures of the os magnum may be caused either by direct violence over the bone, or may result from indirect force applied to the head of the second, third, or fourth metacarpal bone of sufficient force to bring about forcible flexion at the wrist joint. Destot<sup>1</sup> and Gallois have succeeded in experimentally producing a decapitation of the neck of the os magnum, but usually a fracture of the posterior lip of the radius resulted.

The trapezium, by its protected position and its ligamentous attachments, is almost immune to fracture. Kindl<sup>2</sup> attempted to produce fractures of the trapezium by beating on the end of the first metacarpal bone with a hammer and was able to secure only one fracture



FIG. 1  
Fracture of the trapezium.

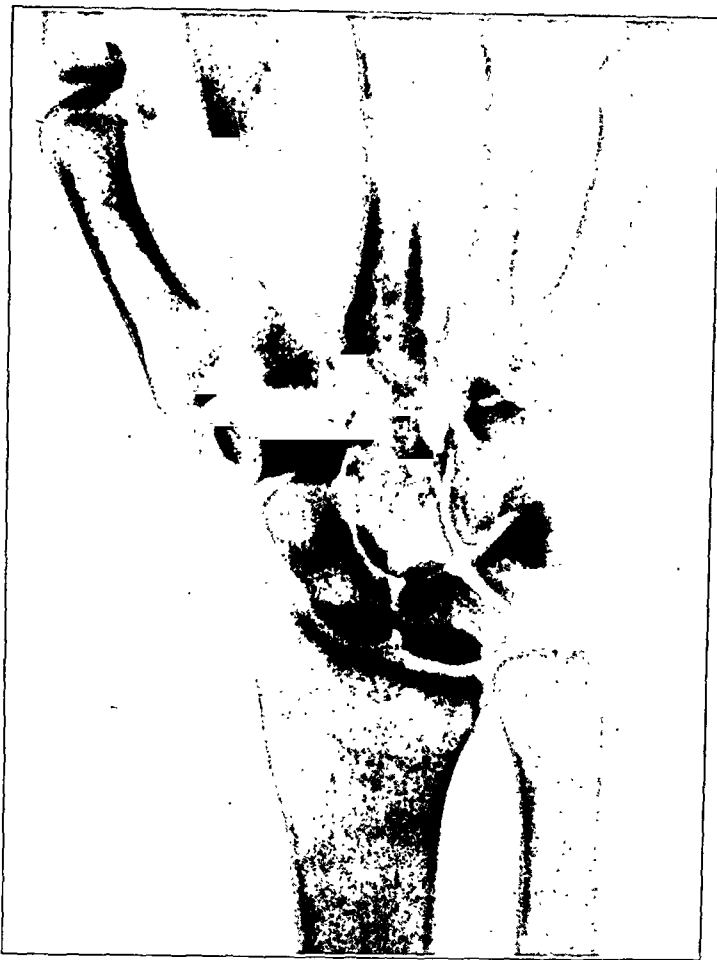


FIG. 2  
Fracture of the os magnum.

of this bone out of ten fractures produced in the thumb and noted that in order to produce a fracture of the trapezium, the thumb must be abducted and its metacarpal bone rigidly flexed.

Fracture of the os magnum and trapezium may occur as a result of direct or indirect trauma, the latter being by far the more common. Although any of the carpal bones may be broken by direct injury, as by a severe crushing wound, such fractures usually involve multiple carpal bones with considerable crushing of the soft parts. Indirect violence, resulting in an isolated carpal

bone fracture, is the more common mechanism, coming usually from a fall on the hand.

In os magnum fractures, swelling, especially on the dorsum of the hand, may be considerable, with tenderness localized over the involved bone. At times the pain may radiate to the fingers, following the course of the median nerve. Crepitus is seldom elicited. In fractures of the trapezium, swelling and pain on the radial side of the wrist at the base of the thumb may be pronounced, with pain on motion of the thumb.

Treatment in fractures of the os magnum consists of complete immobilization of the hand in straight extension for four weeks. These fractures all tend to heal by bony union and, although there is prolonged swelling and pain, the prognosis is good. Excision of the os magnum is necessary for dislocated fragments or persistent symptoms of pain, stiffness, or great loss of function.

In fractures of the trapezium, immobilization of the thumb and wrist, with the thumb placed in slight abduction and at an angle of forty-five degrees to the carpus, is necessary for eight weeks.



FIG. 4  
Fracture of the os magnum.



FIG. 3  
Fracture of the os magnum.

## REPORT OF CASES

CASE 1. Fracture of the trapezium (Fig. 1). Miss L., while crossing the street, was knocked over by an automobile. There were multiple contused areas, especially on the left side of the body, including a fracture of the lateral condyle of the left femur. She also complained of pain on the radial side of the left wrist, especially on motion of the thumb. There was some swelling on the radial side of the wrist and on x-ray examination a fracture of the trapezium was revealed.

CASE 2. Fracture of the os magnum (Fig. 2). Dr. R. awoke one morning complaining of pain in the right wrist. There was no history of trauma. On examination there was swelling of the wrist especially on the dorsal aspect with exquisite tenderness on pressure over the bone. An x-ray revealed the fracture.

CASE 3. Fracture of the os magnum (Fig. 3). Miss S., one of our nurses, slipped while walking in the corridor of the hospital. Attempting to break the force of the fall, she landed on her right hand. She immediately complained of pain in the wrist shooting down into the fingers, pain on motion of the fingers, with excruciating pain on pressure over the os magnum. The x-ray revealed a fractured os magnum.

CASE 4. Fracture of the os magnum (Fig. 4). Miss V. This patient gave a history of having fallen out of a first floor window, landing on her wrist. She immediately complained of severe pain in the hand and wrist, with inability to flex the fingers because of the severe distress such movements precipitated; inability to pick up objects and radiation of the pain along the course of the median nerve. When seen, the hand was markedly swollen, especially the dorsal aspect. Palpation revealed a very distinct localized area of tenderness over the os magnum which the x-ray showed to be a fracture.

## CONCLUSIONS

1. Isolated fractures of the carpal bones, except for the scaphoid, are uncommon.

2. Three cases of fracture of the os magnum and one fracture of the trapezium are recorded.

3. Every injury of the hand or wrist should have a most thorough study, including a critical roentgenographic examination.

4. Many cases of so called "sprains", "synovitis", "arthritis", and "rheumatism" are in reality unrecognized fractured carpal bones.

5. Early recognition and adequate treatment are of extreme importance for the ultimate function of the wrist frequently depends upon this early knowledge.

6. Isolated carpal fractures result more frequently from indirect trauma, although direct injury may be the factor.

7. The prognosis in such fractures is usually good, since they heal by bony union.

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1. DESTOT, É. A. J.: *Injuries of the Wrist; a Radiological Study*. Translated by F. R. B. Atkinson. Ed. 8. London, Ernest Benn Ltd., 1925.
2. KINDL, J.: *Isolierte Handwurzelknochenverletzungen*. Beitr. z. Klin. Chir., LXVII, 549, 1910.

# STRUCTURAL SCLIOSIS SECONDARY TO SYRINGOMYELIA

## REPORT OF THREE CASES

BY SAMUEL KLEINBERG, M.D., NEW YORK, N. Y.

The etiology of structural scoliosis has always been, and still is, obscure. The term idiopathic has come into use in relation to the vast majority of cases to indicate that the basic causal factor is unknown. Even the exact mechanism of the production of a scoliosis is still undetermined. But in some instances, the minority to be sure, the chief element in the origin of the muscle imbalance, or the postural change leading to the curvature, is apparent, and is considered etiologically responsible for the scoliosis. Thus rickets, infantile paralysis, torticollis, visual defect, empyema, disparity in the length of the lower limbs, and certain neurological lesions may lead to a structural scoliosis. Among the neurogenic causes Friedreich's hereditary ataxia is perhaps the most common. Of this type most any surgeon of experience has seen a half dozen instances. Syringomyelia, however, is an unusual and rare cause of scoliosis. In cases of syringomyelia scoliosis occurs often enough, but the disease itself is uncommon and rarely met in an orthopaedic practice. Neurologists take it for granted that scoliotic distortion of the trunk is a feature of syringomyelia, and are so engrossed in the disability resulting directly from the sensory, motor, and trophic lesions, that they pay little attention to the spinal deformity and seldom consult an orthopaedic surgeon.

Syringomyelia is a disease of the spinal cord alone, or the spinal cord and the brain. The essential pathological change is a destruction of the nervous tissue with cavity formation. The loss of tissue may be the result of a congenital malformation, a degenerative postnatal process, or an acquired infection. The symptoms consist of (1) dissociation of the sensory phenomena with loss of the pain and thermal sense, but not of the sense of touch; (2) motor phenomena varying from fibrillation and twitching of the muscles to distinct paresis; (3) trophic disturbances of the skin, muscles, and joints; and (4) gross deformities of the trunk and extremities.

Several cases are here recorded because: (1) syringomyelia is comparatively rare; (2) the patients exhibited characteristic and severe manifestations of the different groups of symptoms; (3) by a fusion of the spine of one of the patients, her posture and gait were improved and her disability reduced. This encourages the hope that early stabilization of the spine by an operation on the vertebral column may prevent the progress of the scoliosis to the customary severe degree, and may enable the individual to stand and walk more naturally and with greater ease.



## CASE REPORTS

CASE 1. Elinor G., ten years old, was referred to me nearly one year ago by Dr. Elihu Katz for an increasing severe deformity of the spine and very great difficulty in walking. The birth of this child was attended by much manipulation and considerable trauma to various parts of the child's body. At the beginning of labor the buttocks presented. The obstetrician tried to turn the child but was not successful, and finally delivered it by a breech presentation. The mother was told that one of the collar bones was broken, and that the legs had been stretched a great deal in the course of the delivery. Immediately after birth the right arm had to be immobilized in a sling, presumably for fracture of the clavicle. It was noted also that the right eye was fixed; it remained so for three months. Furthermore, there was no power in either lower limb. The physical development of the child had evidently been interfered with, for the child did not begin to stand until she was four years old, and she was six years old before she could stand without assistance. The child's mental development was entirely normal.



FIG. 1

Case 1. Patient with structural scoliosis secondary to syringomyelia. Front and back views of patient with left lower limb prepared for traction. Note the severe scoliotic deformity of the trunk with telescoping of the chest into the pelvis, marked angulation of the ribs and obliquity of the pelvis. There are numerous scars on the back, some due to pressure sores and others resulting from skin-grafting operations.

The curvature of the spine was discovered when the child was six months of age; it increased continuously. During the first six years of her life this child received massage to her back and plaster jacket or corset supports. She then had a corrective jacket applied for the purpose of forcibly straightening her spine. This caused a terrific slough of the skin which took eight months to heal, and required extensive skin-grafting. At this time, about one year ago, it was first discovered, according to the mother's statement, that the child had a neurological disease.

*Examination:* January 14, 1932. The patient was in fair general condition. She was much undersize and underweight and was just about able to stand and walk a little without support. There was present a severe right dorsolumbar scoliosis (Fig. 1), with a moderate compensatory curve to the left in the upper dorsal area. There were numerous scars, some from



FIG. 2

Case 1. Anteroposterior roentgenogram, showing a severe right dorsolumbar scoliosis with marked rotation and deviation deformity of the vertebrae from the sixth dorsal to the sacrum. The obliquity of the pelvis is clearly visible. Note the closeness of the ribs to the pelvis on the left side.

pressure sores and others from attempts to skin-graft the ulcers. The pelvis was oblique, its right superior spine two inches below the left. The face and upper limbs were not affected, but there was marked involvement of the motor apparatus of the lower extremities.

A roentgenogram of the spine (Fig. 2) showed a severe right dorsolumbar scoliosis, with a marked lateral tilt of the pelvis. The pelvis, though much tilted laterally, was fortunately not otherwise distorted.

*Neurological Examination:* There was generalized atrophy of the muscles of the back, thorax, and lower limbs. The deep reflexes of all four limbs were not elicited. The plantar reflexes were equivocal. The abdominal reflexes were absent. A sensory examination showed that anteriorly from the fourth dorsal to the twelfth dorsal vertebra there was complete loss of appreciation of pin prick; touch was retained. The extremes of temperature (heat and cold) were not recognized as such in the areas from the fourth dorsal to the fourth lumbar anteriorly and from the fourth dorsal to the first lumbar posteriorly. The oculomotor apparatus and the cranial nerves showed no deviation from the normal. The fundi were normal.

The neurological examination indicated that this patient had syringomyelia, with a structural scoliosis arising from the imbalance of the muscles of the back. Nothing much in the way of therapeutics could be done for the central nerve lesion. However, something had to be done for the increasing deformity of the back which, quite aside from the troublesome features of the syringomyelia, was causing a severe disability. Experience in other institutions had shown that pressure sores appeared readily, and several times not only interrupted the treatment and nullified its good effects, but necessitated prolonged care for their healing, and, at least on one occasion, required skin-grafting. It was manifestly imperative to treat the scoliosis in order to prevent further increase of the curve. It was at the same time important to avoid ill effects from the treatment, such as pressure sores.

It was decided to apply the method of treatment which I have for years found to be the simplest, and withal the most effective, of the present systems,—namely, traction on a convex frame followed by a spine fusion. The patient was placed on a frame specially designed by my assistant, Dr. Herzmark. Traction was applied to the head and to the left leg. At the same time a box was placed at the foot of the bed between the right foot and the bed posts for counterpressure. The traction was gradually increased and was maintained for about four weeks, at the end of which time the back looked much improved and a roentgenogram showed that the curvature was considerably reduced (Fig. 3). The spine was then fused by operating on the vertebrae from the tenth dorsal to the sacrum inclusive. Although the patient was a poor subject for a spine fusion she stood the operation very well, and was in good condition when she left the operating room. The wound healed by primary union. Traction was reapplied at the end of two weeks. Six weeks after the operation a corrective plaster jacket was applied, including the left arm and left leg. The patient was kept in plaster for two months, after which she received a celluloid corset.

At present she is much improved. She walks much better than ever before and without any assistance. Her mother is particularly pleased because the child has become independent and gets about and does things for herself without constantly seeking help.

CASE 2. Mr. A. B., thirty-seven years of age, recently consulted Dr. Milgram, to whom I am greatly indebted for the privilege of reporting the case. The patient's chief complaint was difficulty in walking of seven years' duration. The man was apparently well until his thirteenth year when it was noticed by his mother that his spine was becoming deformed. During the succeeding five years, despite active treatment, including recumbency on a convex frame, the curvature increased. While in bed a large ulcer appeared on his back, over the convexity on the right side. This never fully healed and is still a source of discomfort. During the following twelve years he got along tolerably well as a peddler. Seven years ago there appeared difficulty in walking, tiredness on

locomotion, and an inability to raise his right lower limb and bring it forward. This condition has grown progressively worse, so that at present he must hold on to the furniture to walk about the room. In addition, he has noticed in the past year that the "right leg has felt somewhat numb in places".

Examination showed the presence of a marked scoliosis as shown in the photograph

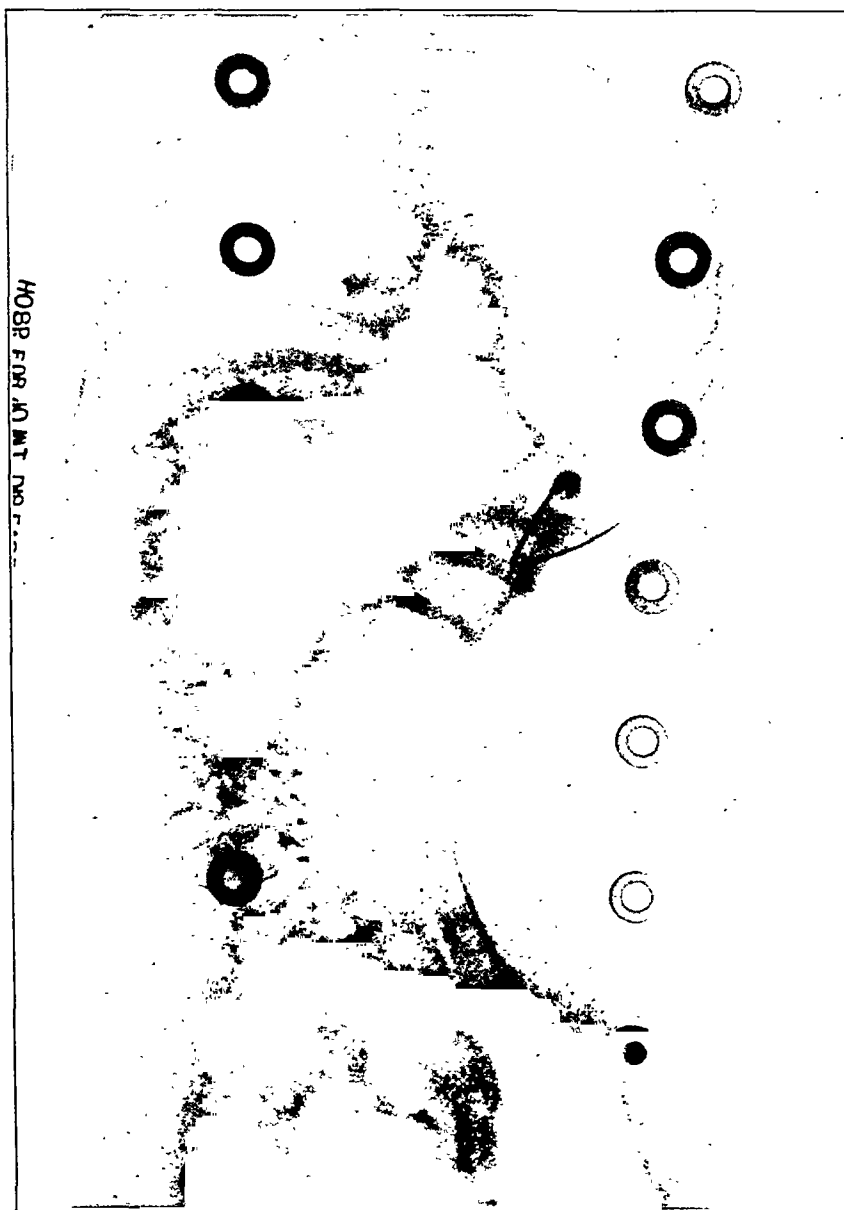


FIG. 3

Case 1. Anteroposterior view after several weeks of traction. Note the marked reduction in the curvature. There is an increase in the length of the trunk and the capacity of the chest and abdomen. The pelvic obliquity is improved.

(Fig. 4). The posterior view exhibits a large scar on the right side of the back,—i.e., the convex side of the curvature. The patient stands with his lower limbs flexed at the hips, knees, and ankles, as was seen in my first case. The gait is staggering, unsteady, and of the spastic type. The neurological findings indicate the existence of syringomyelia.

The salient features in this case are progressive deformity of the trunk, disturbance in the thermal sense, retention of the tactile sense, weakness

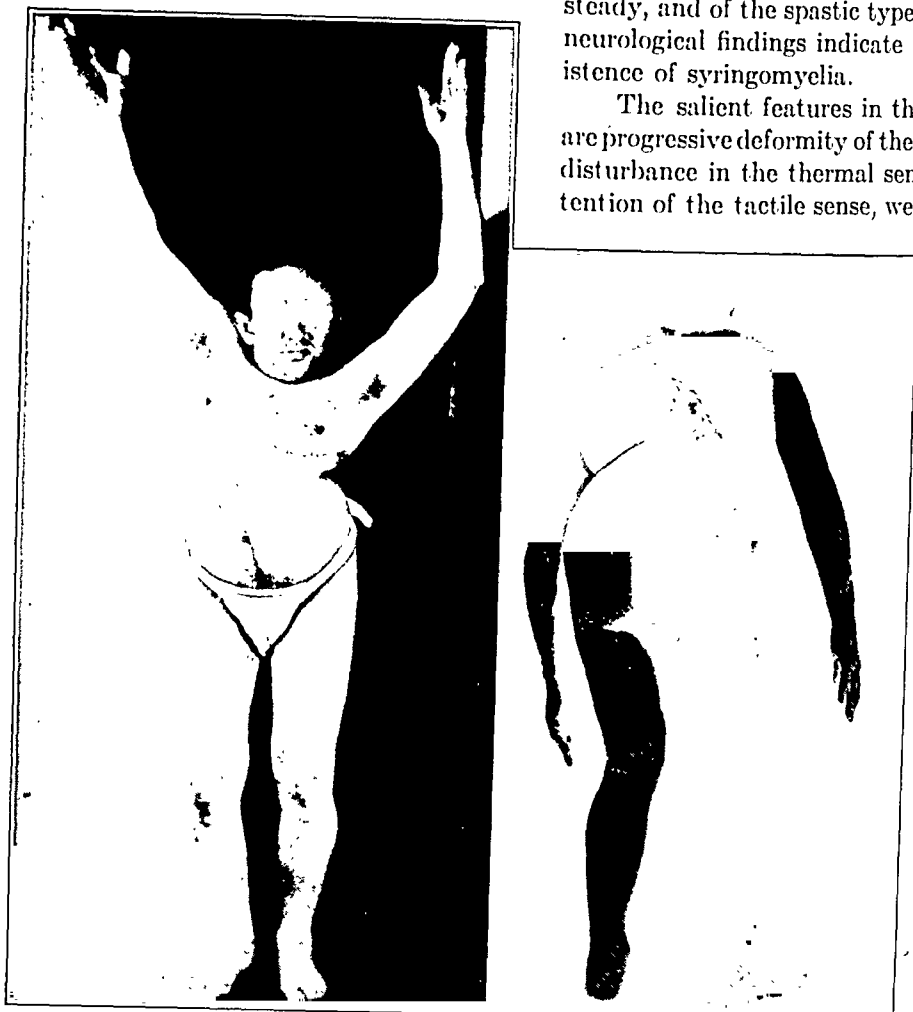


FIG. 4

Case 2. Front and back views showing a severe right dorsal scoliosis. Note the large irregular scar on the right side of the back. The attitude of flexion of the lower limbs is apparent.

in the muscles of the lower limbs, and marked alterations in the deep reflexes. From these findings one may conclude that the patient has a structural scoliosis due to syringomyelia.

CASE 3. Samuel H., thirty-four years old, consulted my associate, Dr. Joseph Buchman, for paralysis of the left upper limb. The patient had no difficulties until three years ago when he noticed some stiffness in the left middle finger. This was followed by the onset of weakness which involved progressively the hand, forearm, and arm. Recently the shoulder became affected so that the patient had very little power in the whole of the left upper limb. The onset of this weakness was accompanied by pain along the left side of the head radiating down to the point of the shoulder. Ten weeks ago stiffness and weakness appeared in the right upper extremity and more recently similar symptoms were experienced in the left thigh.

Examination showed that the patient is a well nourished individual with a marked right cervicodorsal structural scoliosis (Fig. 5). There is a left Horner's syndrome,—



FIG. 5

Case 3. Anteroposterior roentgenogram of spine, showing a marked right dorsal structural scoliosis with the usual changes in the thoracic cage.

that is, the left pupil is abnormally small, the palpebral fissure is narrowed, and there is an enophthalmos. Sensation in the face is normal and there are no bulbar disturbances. The extremities and trunk present sensory and motor disturbances and changes in the reflexes that are characteristic of syringomyelia. This patient, as the two previous, has a structural scoliosis complicating a preexisting syringomyelia. There was no opportunity for treatment of the spinal curvature.

#### DISCUSSION

The cases here detailed are typical of syringomyelia exhibiting the usual neurological changes. In the history of all of the patients it is apparent that in this lesion there is early a strong tendency for the curva-

ture of the spine to progress to a severe degree. While most of the motor disturbance, general instability, and locomotor disability is due to the lesion of the spinal cord, yet it would seem reasonable to believe that the deformity of the spine and trunk may contribute toward the disability. Moreover, even if that were not so, it would be advantageous to check, if possible, the progress of the curvature. With that in mind the first case, a child, had a spine fusion operation. It is too soon, indeed, to be certain of the final outcome, but from present appearances, and from the experience in other types of severe scolioses, the spine seems stabilized and the scoliosis under control. The other cases were in adults in whom the deformity was already advanced and in whom there was no opportunity for spine fusion.

Although the etiological factor—namely, an organic lesion of the spinal cord—is beyond our reach, we should not hesitate to apply orthopaedic treatment for the curvature. Some years ago I had several cases of scoliosis secondary to Friedreich's hereditary ataxia. The patients were much improved by continued support of the back with corsets. In at least one of them improvement progressed so far that the patient was able to resume her studies in college, and she acquired enough motor steadiness so that she was able to walk several miles a day. At present I have under my care a boy with scoliosis secondary to Friedreich's hereditary ataxia. As his deformity was increasing, I fused his spine. There has been no further increase in the deformity and the boy is getting about freely and with greater ease. I believe, therefore, that in syringomyelia the spine should be operated on as early as the diagnosis is established for the following reasons: (1) to stabilize the spinal column and thereby improve the posture and gait, (2) to prevent increase of the curvature.

## A NOTE ON POSTURE IN RELATION TO FLAT FEET

BY L. E. SNODGRASS, M.D., PHILADELPHIA, PENNSYLVANIA

*Episcopal Hospital, Philadelphia*

Flat feet occurring in patients with poor posture is an every-day observation. The emphasis in the past, however, has been largely directed toward the kyphosis part of the deformity in this relationship. The purpose of this brief paper is to stress the effect of the constant compensatory lordosis. These observations are based on a study of the anatomy involved, on the cadaver, and in the living.

For all practical purposes, it may be accepted that the pelvis moves with the lumbar spine. Lordosis is accompanied by rotation of the pelvis about a transverse axis drawn through the femoral heads, so that the iliac crests move forward and the symphysis pubis downward and backward. In this manner the upper attachment of the fascia lata to the pelvic brim is moved forward, and by its hammock-like function, which was clearly demonstrated by Allis<sup>1</sup> in 1896, brings the great trochanter forward in relation to the pelvis in the standing position. This forward movement of the great trochanter is internal rotation of the leg.

In a foot with normal arches, the internal malleolus is found somewhat anterior to the external malleolus. In the patient with flexible pronated flat feet, it will be found that this relationship is disturbed and that the malleoli are directly opposite one another, or more nearly so. Selecting an intelligent patient with definite flexible pronated flat feet, and with the feet pointing directly forward,—*i.e.*, parallel but not in contact with each other, the patient is instructed to stand at ease. After carefully noting the position of the malleoli, the patient is requested to turn his legs outward, but not to move his feet. It may be necessary to hold the fore part of each foot on the floor to demonstrate the external rotation of the leg on the foot which takes place. By this movement the posterior part of the foot rotates outward with the leg, so that the scaphoid goes upward and laterally and the upper part of the os calcis moves laterally, bringing the attachment of the tendo achillis inward where it comes to lie in its normal position over the mid-line of the ankle joint. It should be noted that the origin of the gastrocnemius is moved laterally by internal rotation of the leg, which tends to tilt the upper part of the os calcis inward.

The writer is keenly aware of the danger of confusing cause and effect in any study of flat feet. One may accept the view that flat feet is but one manifestation of weakened muscles and ligaments throughout the body, requiring no further anatomical explanation. But, if this position is taken, then one must explain the constant escape of the knee joint from derangement, for, second only to the joints in the foot, the knee transmits more body weight than any other freely movable articulation. It is



recognized that back-knee and lateral mobility of the knee are very uncommon findings in patients with flat feet. It is true that patients with bilateral congenital dislocation of the hip develop lordosis, but do not invariably have flat feet. In these patients, however, the lordosis is definitely secondary to the condition in which the pelvis is supported from points posterior to the acetabulum.

The correction of the posture should be our first aim in treatment. Whether or not we regard the lordosis as primary, by its correction we will more permanently correct the flat feet than by simply bracing up the arches by shoes with pads or plates. The correction of the deformity in the foot should not be neglected, but the weight of the body and its leverage through the internal rotation of the leg will prevent a permanent improvement of the foot condition until the posture is corrected.

1. ALLIS, O. H.: *An Inquiry into the Difficulties Encountered in the Reduction of Dislocations of the Hip*. The Samuel D. Gross Prize Essay, Philadelphia, 1896.

## EWING'S TUMOR: AN UNUSUAL CASE

BY ALEXANDER S. PAPADOPOULOS, M.D., ATHENS, GREECE

*Chief Surgeon of the Orthopaedic Section in the General Hospital for Refugees,  
Athens, Greece*

Endotheliomata of the bone, however rarely they may occur, constitute, nevertheless, a well defined morbid entity. Following is the first case of endothelioma of bone recorded in Greece. Our indebtedness to the American authors for their thorough study and knowledge of this disease is a recognized fact. In spite of a certain number of disputed points which still prevail as regards its origin and initial starting point, Ewing's tumor is accepted today as a well defined clinical, anatomico-pathological entity.

Authors refer, as a rule, to the great similarity which exists between Ewing's tumor and the most common of bone affections, such as the chronic osteomyelitis of tuberculosis; if error and confusion are common in the usual forms of Ewing's tumor, they are inevitable when the tumor has a juxta-epiphyseal development. Error is always possible in clinical work, especially in cases as rare and uncommon as Ewing's tumor, in which, except for the anatomical characteristics of the tumor, no sign nor symptom possesses a real pathognomonic character. However, the perusal of a large number of reported cases gives the impression that the initial symptom as revealed by the roentgenogram—namely, that of a bone condensation—is an important one which should always be taken into consideration as a serious inference of Ewing's tumor.

In the case reported the truth of this fact was evident and constitutes the principal reason for its publication.

### CASE REPORT

H. S., female, aged nineteen, from Asia Minor, with a negative previous history and in good general health, in January 1931 began to complain of slight pain in the left knee joint which was attributed to an excess of walking. The pain became gradually more pronounced and she was obliged to apply to our Hospital Dispensary for advice. At this time, March 1931, there was no local manifestation to explain the persistence of a deep, constant pain in the knee joint; movements were entirely free; there was no swelling and no difference in the circumference of the limbs. The only suggestive sign was a painful point situated on the upper and inner portion of the tibia. The laboratory examination of the blood was negative as regards the Wassermann reaction and there was no alteration from normal composition and number of the red and white corpuscles. The roentgenographic examination was important because it disclosed a dark area of bony condensation situated on the inner portion of the tibial epiphysis, which was of difficult interpretation. Because of the slight degree of emaciation and pallor, the possibility of a local tuberculous reaction in the epiphysis of the tibia was considered, for which rest and general treatment were recommended.

The patient returned one month later without amelioration of the pain, presenting on the contrary a number of new painful areas about the knee joint. The diagnosis of tuberculosis seemed confirmed, and a plaster cast was immediately applied with a window for sun exposure.

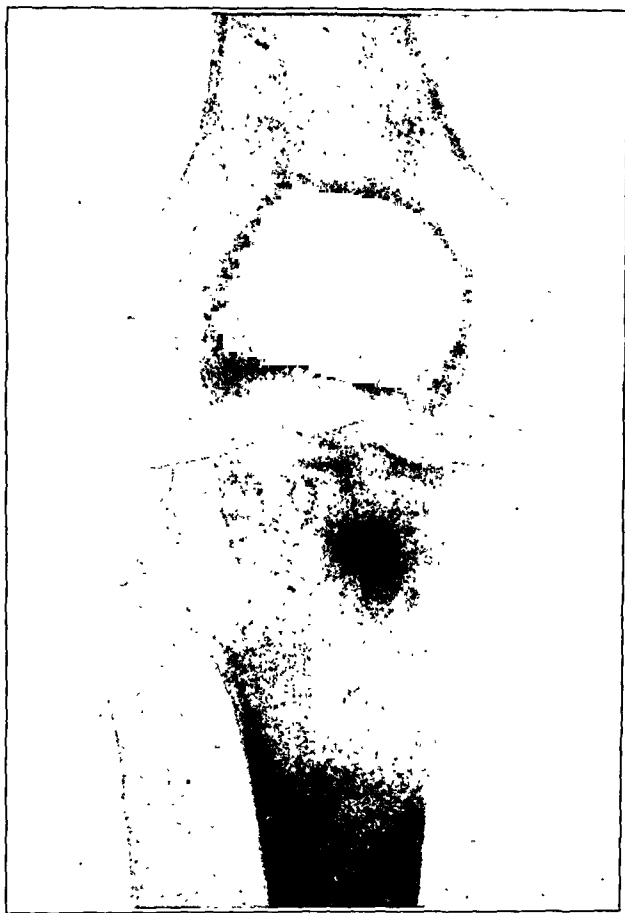


FIG. 1

Roentgenogram taken March 13, 1931.

*The symptoms gradually increased in severity. The patient suffered continually, and it was necessary to remove the cast one month later. At this time the upper portion of the leg presented a clear swelling, with fluctuation and marked local irritation of the knee. The roentgenogram showed a longitudinal and irregular extension of the dark shadow, forming a column an inch in length, with a zone of rarefied bony tissue on the outer side, but the periosteum did not seem to be involved in the local process. An onion-like formation seemed apparent on the outer side of this dark column. The clinical signs recorded at that time were: atrophy of the thigh two-thirds of an inch, local swelling and elevation of temperature, with appearance of dilated subcutaneous veins. The diagnosis of tuberculosis could no longer be held, but the condition indicated the presence of some uncommon inflammatory process or a rare variety of tumor which was beginning with a strong reaction of bony condensation. Ewing's*

tumor suggested itself to us and biopsy was advised with the possibility of a radical operation if necessary after anatomico-pathological confirmation. The advice was not followed and the patient consulted another surgeon who made the diagnosis of tuberculosis and the limb was again immobilized in plaster-of-Paris.

Two months later, the patient returned to the hospital, showing exhaustion, emaciation, and pain and marked swelling of the knee.

On June 10, 1931, under a general anaesthesia, biopsy was attempted with the expectation of finding a tumor. After opening, there was found pure blood and a number of small organized granulations contained in a false cystic cavity in the compact tibial bone, the hard steel-like consistency of which confirmed the x-ray diagnosis. There being no further evidence to confirm the macroscopic nature of the lesion, we did not feel free to proceed to a radical operation. The wound healed by first intention. The laboratory reports, however, were as follows: "No microbe or other organism; the examination of a portion of the tissue showed ordinary cells which are usually found in inflammations, and nothing more." The report was in obvious contradiction to the clinical evolution of the disease.

The swelling rapidly increased and, at the end of July, x-rays showed marked extension of the lesion, with the destructive process in advance of the condensation at this time. Emaciation was extreme and, in spite of the negative laboratory findings, amputation of the thigh was performed.

Examination of the tumor gave the following findings: "The histological examination of the tumor proves it to be of a small round-cell sarcomatous structure, rather of a peritheliomatous character. As a rule, the cellular disposition is alveolar, or, rather,

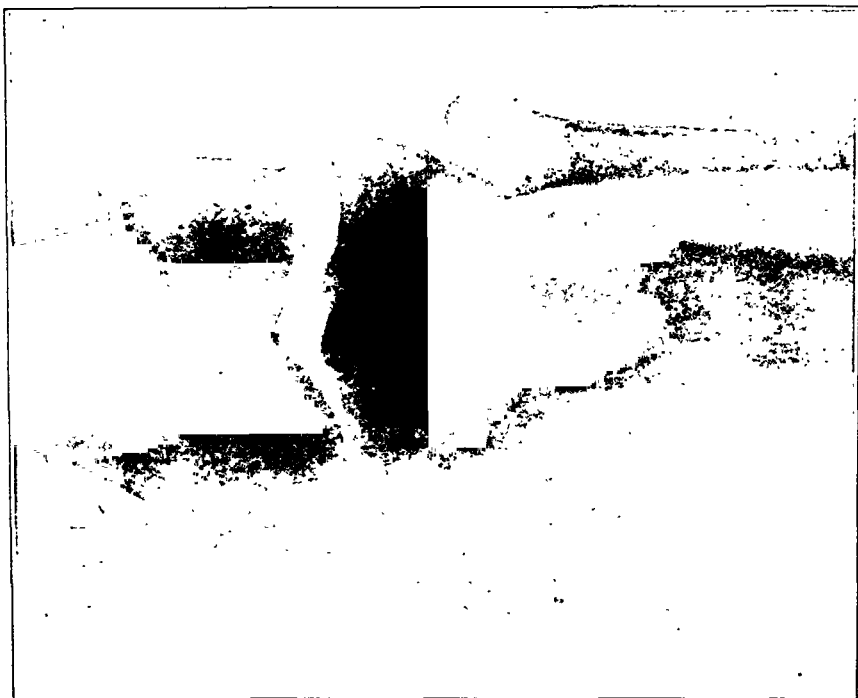


FIG. 3  
Roentgenogram taken June 17, 1931.



FIG. 2  
Roentgenogram taken April 29, 1931.

pseudo-alveolar. The cells are small and polyhedral, with one nucleus round or oval. No nucleoli. Some atypical mitotic forms are found here and there. The cells form a regular sheet, interrupted here and there by newly formed vessels or fibrous tissue. The abundance of the newly formed vessels and the irregular mitosis of the cells suggest the extreme malignancy of the tumor.

"Macroscopically, the tumor is suggestive of the bony myelomata, vascular, and divided by fibrous columns."

The patient made some improvement after the operation, but returned in January 1932 with double hemothorax, dyspnea and intrathoracic pain. The x-ray showed double hemothorax, but no metastasis could be determined. The patient died on March 8, 1932. Autopsy was not permitted.

The case was interesting from several points of view. After first presenting for some weeks a vague resemblance to tuberculosis of the tibia, a clearly circumscribed point of condensive osteitis was shown by the x-ray, which is rarely ever found in tuberculosis. This important information given by the x-ray is, in our opinion, one of the most important indications in favor of Ewing's tumor, since in no other inflammatory or neoplastic process is this local reaction usually met. We agree with Herendeen's assertion that the diagnosis of Ewing's tumor can be made from the roentgenograms alone, and this was true in this case during the entire duration of the illness. The biopsy itself was not devoid of practical instructive results, for it revealed the local anatomical characteristics of Ewing's tumor in which only blood and rare small particles were found, and these were taken by the pathological laboratory to be the result of ordinary inflammatory reaction. These anatomical irregularities are frequently mentioned in Ewing's tumor bibliography and one is tempted to question if many of these errors are not the result of incomplete intracellular examination rather than, as is maintained by some authors, the result of a coexistence of ordinary inflammation usually preceding the neoplastic transformation.

In spite of its rarity, Ewing's tumor is an interesting variety of malignant tumor and every case should be published and studied thoroughly. We wish to acknowledge our indebtedness to the excellent review of the subject contained in the article by Dr. Sevier.<sup>1</sup>

1. SEVIER, C. E.: Ewing's Tumor (Endothelial Myeloma). Report of an Atypical Case. *J. Bone and Joint Surg.*, XII, 929, Oct. 1930.

# TUBERCULOSIS OF THE HIP JOINT FOLLOWING CLOSED REDUCTION OF CONGENITAL DISLOCATION OF THE HIP \*

BY CHARLES N. PEASE, M.D., F.A.C.S., CHICAGO, ILLINOIS

Changes in the head of the femur and acetabulum following closed reduction of congenital dislocation of the hip joint are not uncommon. Osteochondritis deformans (Legg's disease), atrophy of the femoral head, non-specific epiphysitis with thickening of the neck of the femur and a true traumatic arthritis of the hip joint occur frequently, but tuberculosis involving the hip joint following reduction has not hitherto been reported.

The following is a case report describing such a complication.

L. E., white girl, eight years old, was admitted on October 10, 1931 to the Orthopaedic Service of the Children's Memorial Hospital. A typical history of congenital dislocation of the left hip was obtained. The first reduction was accomplished when the child was six years old, but subluxations on two occasions required further manipulations and casts. Birth was normal. There was no history of tuberculosis in the family. On this admission patient walked with a limp on the left side. Motion of the left thigh was



FIG. 1

Typical unilateral congenital dislocation of hip.

\* From the Orthopaedic Service of Dr. Fremont A. Chandler at the Children's Memorial Hospital. Presented before the Joint Meeting of the Clinical Orthopaedic Society and the American Academy of Orthopaedic Surgery at Chicago, January 14, 1933.

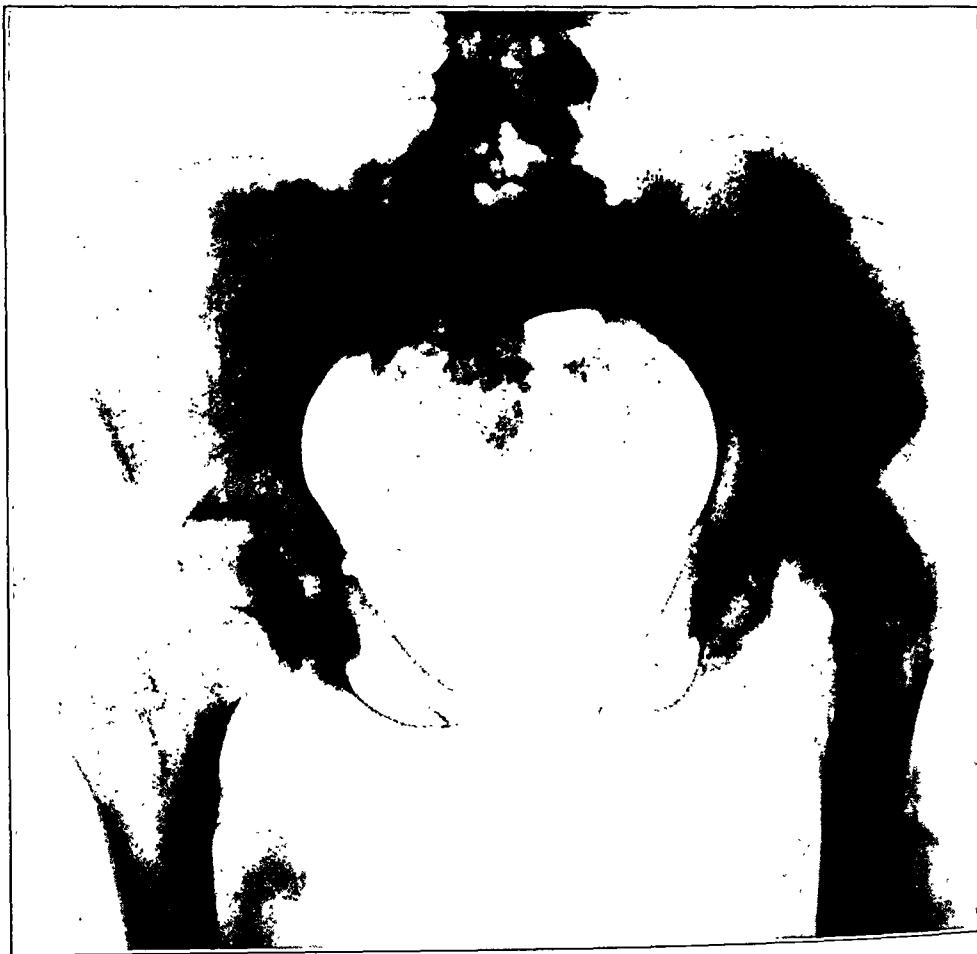


FIG. 2

Following first reduction. There is a subluxation with loss of outline of joint space.

limited in all directions by involuntary muscle spasm. The Von Pirquet test was negative. Roentgenogram revealed the head of the femur not completely replaced in the acetabulum. There was a thinning of the joint space and a marked atrophy of the left ilium and femur. A diagnosis was made of an incomplete reduction of congenital dislocation of the hip plus a superimposed arthritic process.

On October 14, 1931, under a general anaesthesia, the hip was abducted and internally rotated and, with the knee slightly flexed, a spica cast was applied. Ten days later the laboratory reported finding, from smears obtained from the nose and throat, streptococcus viridans, staphylococcus aureus, and micrococcus catarrhalis. Cultures from the stool revealed bacillus coli, streptococcus viridans, and staphylococcus aureus. Blood cultures after twenty-four hours, forty-eight hours, and seven days were negative. Intracutaneous test with streptococcus viridans was positive. The patient was discharged from the hospital on November 11, 1931 to the out-patient department where she received weekly injections of autogenous vaccine.

She was readmitted to the hospital on January 8, 1932, when the cast was removed. Mantoux test, minus one-tenth milligram, was made and in twenty-four hours it was definitely positive. Roentgenograms at this time showed an excessive amount of bone atrophy of the left hip and a loss of the bone outline in the joint suggestive of tuberculosis.

On February 9, 1932, an exploration and biopsy of the left hip joint were performed. On inspection there was no free fluid present in the joint. There was very little granulation about the head of the femur. The cartilage of the femur was very atrophic and thin; its usual luster was absent and a dark gray color replaced the usual blue-white appear-



FIG. 3

Complete extra-articular fusion of hip joint.

ance. The capsule was definitely thickened. A small area of dark abnormal tissue was present in the capsule. The impression was that this joint was not tuberculous but rather one which had been subjected to much trauma.

Synovia and a small portion of the head were removed for biopsy. Pathological examination of the tissue showed chronic hyperplastic inflammation compatible with tuberculous granulation tissue. A portion of this tissue was macerated and with it smears, cultures, and guinea-pig inoculation were made. Paraffin sections of other portions of the same tissue were also made. In the direct smears no acid-fast bacilli were found. The cultures remained negative. Guinea pig was killed and autopsied seven weeks after inoculation and tubercles were demonstrated histologically.

On April 12, 1932, through a Smith-Petersen incision an extra-articular fusion was performed. Patient wore a spica cast until September 29, 1932, at which time the hip was firmly fused both clinically and roentgenologically.

#### COMMENT

It is suggested that all patients having persistent involuntary restriction of motion of their hip joints, following reduction of congenital dislocation of the hip, be studied carefully for possible foci of infection causing a secondary involvement of the joint. In addition, the various examinations for tuberculosis should be undertaken and, even if found to be negative at first, a repetition of the examination is indicated.



# CARTILAGE OF THE OUTER CONDYLE OF THE FEMUR AS A FOREIGN BODY IN THE KNEE JOINT

BY G. A. CARLUCCI, M.D., NEW YORK, N. Y.  
*Associate in Surgery, Columbia University, New York*

Many cases of foreign bodies in the knee joint have been reported, but a casual perusal of the literature does not reveal one due to practically the whole cartilage of the outer condyle of the femur.

Due to its unusual features this case is reported in detail.

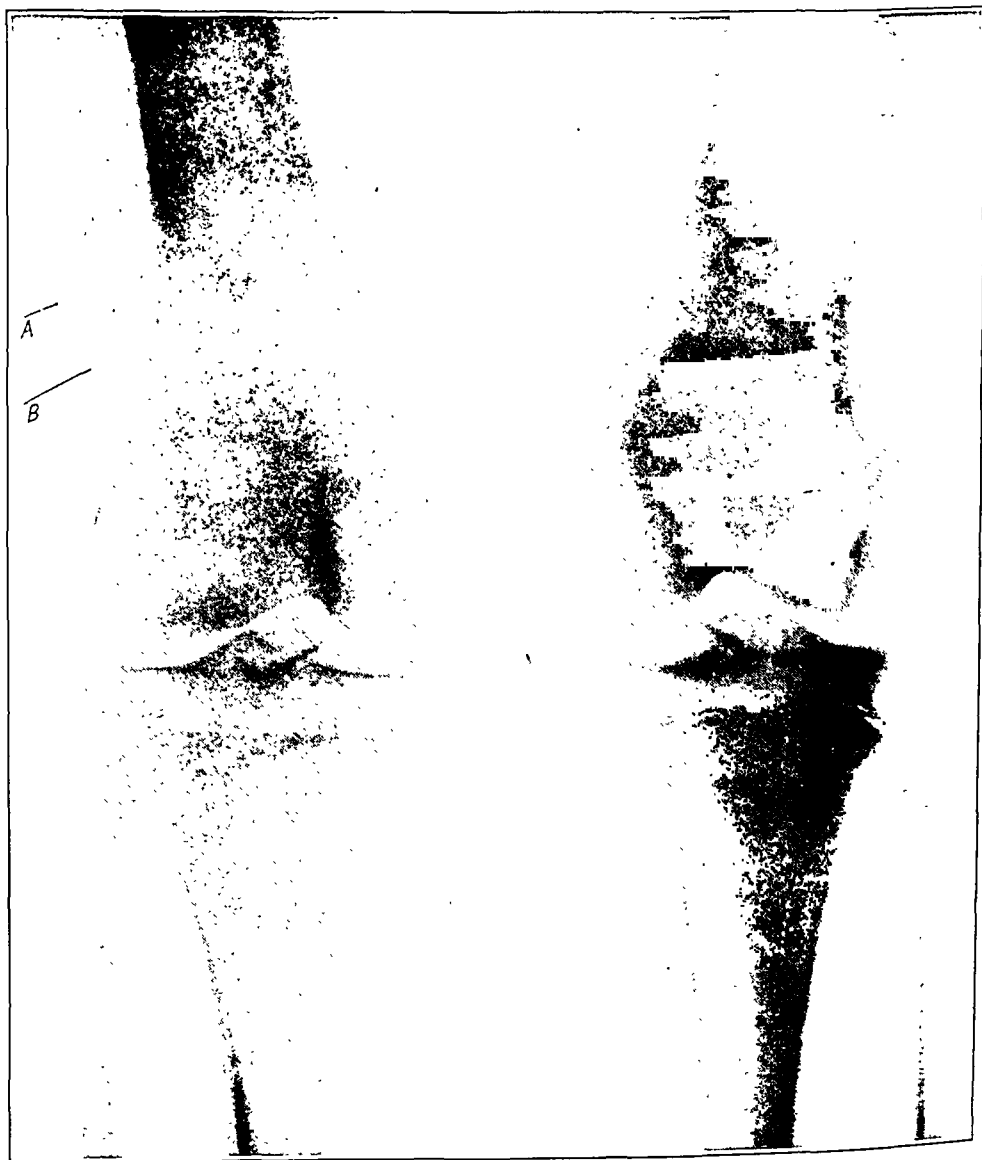


FIG. 1

Anteroposterior view of both knees. A. Crescentic shadow first noted near the exostosis. B. An evident exostosis.

A twelve-year-old girl was first seen by me November 11, 1932. She stated that over three months previously she had twisted her knee as she jumped off a trunk. The exact mechanics of the accident she could not describe. The knee pained her for a while and she was treated with the usual home remedies,—liniment, etc. Some time later, as she continued to limp, she was taken to her local physician who at first treated the condition as a sprain and then, as a chronic swelling of the knee developed, made a diagnosis of rheumatism, gave her salicylates, etc., without any improvement.

As stated above, she was referred to me about three months after the accident. The child walked with a decided limp, had a diffuse swelling of the whole left knee joint, seemed to have a tender spot on the outer side of the outer condyle of the femur, had about twenty degrees of limitation of flexion, full extension, and no lateral mobility of the knee. There was some fluid in the joint proper, as evidenced by the patellar click. There was no atrophy of the muscles and no heat about the joint. Closer examination of the outer side of the external condyle seemed to show the presence of a bony prominence, probably an exostosis.



FIG. 2

Anteroposterior view taken two days later. A. Crescentic shadow in the reverse of its previous position and farther away from the exostosis, B.

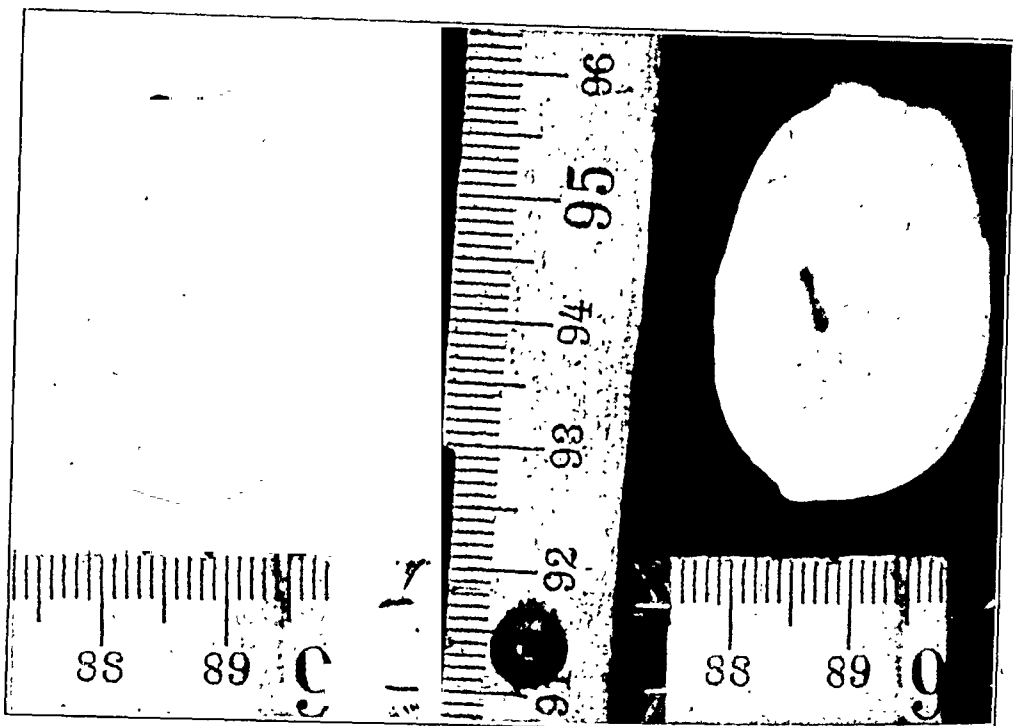


FIG. 3

Foreign body (cartilage of external condyle of femur). Convex side shown at left; concave side, at right.

A tentative diagnosis of an exostosis arising at the site of a partly torn lateral ligament with a chronic synovitis was made and roentgenograms were taken. Fortunately large films were used, taking both knees in the anteroposterior position on the same film. Lateral views were also taken of both knees. In the anteroposterior views the exostosis on the outer side of the knee was readily seen, but just above it a peculiar shadow somewhat crescentic in shape was noted. Whether it was an extension of the exostosis or a beginning myositis ossificans could not be determined at that time.

The knees were again x-rayed the following day and this time the crescent-shaped shadow was completely reversed as compared with the previous picture. A close study was then made of the lateral film and it became apparent that the inferior surface of the outer condyle of the left knee was eroded and apparently lacking in the full curve, as compared with the inner condyle. This difference was also noted in comparing it with the film of the good knee. A diagnosis of a loose cartilage in the knee joint was made and the youngster operated on November 15, 1932.

A four-inch longitudinal incision was made on the outer side of the knee and the joint capsule was found to extend laterally way over to the exostosis on the superior margin of the external condyle. The exostosis was chiseled off, the joint capsule opened, and the fluid evacuated; the loose body was then found under the quadriceps extensor and extracted. The capsule and the skin were sutured with catgut and the knee put up in extension on a splint for a week. The patient was gradually allowed to walk.

She was seen about four months after the operation and roentgenograms were taken. At that time she had only a very slight swelling of the knee, no pain at any time, was going to school regularly, walking without a limp, and had complete range of flexion and extension of the knee. There was no demonstrable lateral mobility. The roentgenograms showed that there was still a roughening of the articular surface in a small area.

This unusual case is reported on account of the fact that the foreign body in the knee joint was nearly the whole cartilaginous surface of the outer condyle of the femur and that it was apparently the result of a very



FIG. 4

Lateral view of normal knee joint (right) showing even contour of condyles of femur.



FIG. 5

Lateral view of left knee joint showing irregular contour of external condyle. A. Loose cartilage not seen.

minor injury. Whether the exostosis was also the result of the injury could not be determined. As a matter of fact it was extra-articular.

It is interesting to note also that the synovial membrane of the knee joint in this case extended well out under the vastus externus, allowing the cartilage to gravitate there and in this manner appear on the roentgenogram. As a matter of fact, at operation the foreign body was under the quadriceps extensor, just above the patella, and I doubt very much if the very fine crescentic line would have been noted in the first roentgenogram if it had been there at that examination. This, of course, emphasizes the fact that it is of the utmost importance to x-ray all these apparently trivial injuries in order to prove that there is no bone injury. As in this case, comparative roentgenograms of the normal joint are of great value; and, whenever there is any doubt, a check-up roentgenographic examination should be made.

The author wishes to make acknowledgment of the excellent roentgenograms of this case taken by Dr. D. Sandroni.

# FIBULA TRANSPLANT TO REPAIR DEFECT IN RADIUS

BY ROBERT D. SCHROCK, M.D., AND HERMAN F. JOHNSON, M.D.,  
OMAHA, NEBRASKA

*University of Nebraska, Department of Orthopaedic Surgery*

A woman, aged twenty-four, presented the problem of a giant cyst of the left radius. "Prickling sensations" in the forearm and swelling were noted six months previously.

Roentgenographic studies of the left forearm on August 10, 1930, "show a cystic expansion of the radius, beginning about two inches below the head and involving a portion of the shaft about two and one-half inches in length. The cortex appears unbroken, but is displaced widely into the soft tissues, making the total width of the radius about three times its normal diameter. There is extensive loss of lime salts from the bone, with no evidence of bone production. The cyst is crossed irregularly by three trabeculations, which grow more numerous as the shaft is approached."

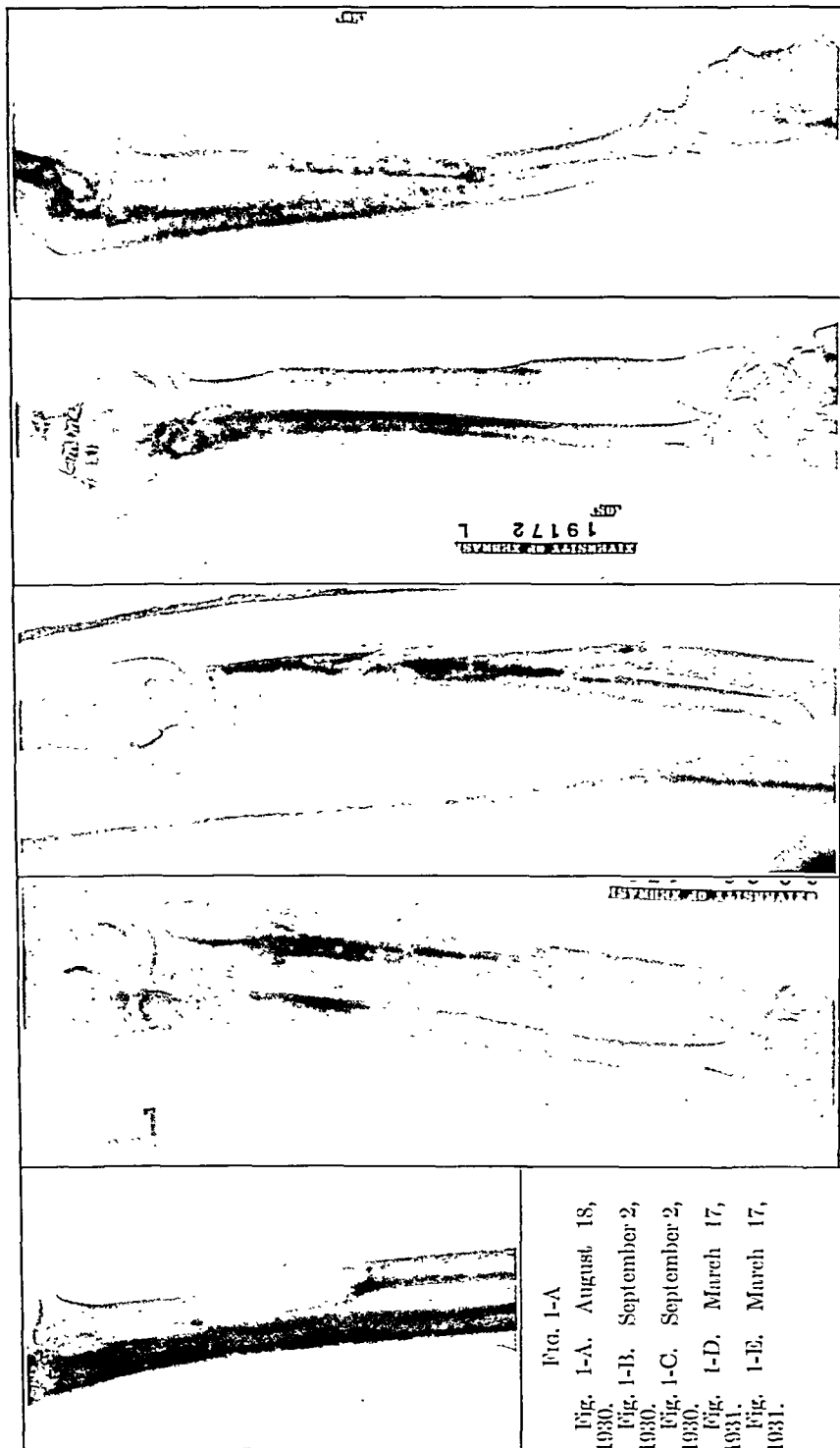
The giant cyst was resected intact with about one-half inch of radius at each extremity, through bone appearing grossly normal. The radial defect was four inches long.

A four and one-half inch segment of fibula with its periosteum was removed; multiple drill holes were made through cortex to medulla at varying levels. The proximal end of the radius was slit incompletely in the horizontal plane; the distal end was slit in the vertical plane; a very narrow wedge of bone being removed from each. The ends of the fibula graft were thinned in corresponding planes; the length of the graft was determined to be slightly longer than the radial defect in order to produce longitudinal stress when set in place.

Progress was uneventful. Contour of the forearm had been restored to normal. Roentgenographic study showed satisfactory development. At the end of seven months (March 17, 1931) the report read: "The fibula transplant has remained viable at each end. It is firmly united to the radius by callus. The proximal point of union is rather indistinct and shows complete union of bone. At the distal end, fibula and radius can still be differentiated. Union is complete." (H. B. Hunt, M.D.)

At this time, no support was being worn. The function of the forearm and hand was ninety per cent. of normal, pronation being slightly limited.

The making of multiple small drill holes through cortex to medulla did not materially weaken the graft and did permit more rapid vascularization of the graft throughout its length. The wedged ends of the graft under pressure in the slotted radial ends brought fibular and radial medullary cavities into intimate contact. Attention was given carefully to avoid torsion strain. These details of presenting opportunity for early vascularization of both medulla and periosteum, together with the exertion of longitudinal pressure, are essential factors in the successful outcome of the four-inch graft of fibula into the radial defect.



## A CASE OF ARTHROKATADYSIS OF THE HIP JOINT

BY EDWARD N. REED, M.D., F.A.C.S., SANTA MONICA, CALIFORNIA

This case is reported as another instance of the condition recorded by Dr. Pomeranz as "Intrapelvic Protrusion of the Acetabulum", and by Dr. Cary and Dr. Barnard as "Arthrokataclasis of the Hip Joint", in *The Journal of Bone and Joint Surgery* of July 1932 (XIV, 663, 687).

A young woman, a graduate nurse, came for examination and treatment because of aching in her right hip and thigh.

### *Complaint:*

Since sixteen years of age she has had intermittent aching in the right thigh, from the hip to the knee, brought on by any considerable amount of walking or standing or by a long automobile ride. She is unable to take part in any athletic sport. There is no aching in the left lower extremity and no manifestation of trouble in any other joint at the present time.

### *History:*

She walked at eight and one-half months. Had the exanthemata of childhood but none unduly severe. Never had scarlet fever or diphtheria. Between four and eight years of age she had, each spring, for three successive years, a severe attack of rheumatic fever, involving principally the feet, knees, and hips, lasting two to three weeks each



FIG. 1

time, but without endocardial involvement or chorea. She was repeatedly obliged to miss school because of "colds" and tonsillitis until ten years of age, at which time her tonsils were removed. She had no more rheumatism after the tonsillectomy, following which she grew very rapidly, having previously been an unusually small child. Throughout adolescence she was very round-shouldered. She played like any other child in grade school but would get very tired. Was obliged to give up basket-ball in high school, because of the reaction it produced in the right hip.

At eighteen years of age she had a severe attack of pain in this hip, causing thigh flexion for two weeks, followed by progressive improvement. In March 1927, roentgenograms were said to have shown a softening of the femoral head. She was put in a hip spica cast, in abduction, for seven weeks, with no weight-bearing for six more weeks. Roentgenograms were taken again in 1928, and she was advised to have complete rest and heliotherapy but, disregarding this advice, continued her nurse's training. The condition progressively improved; at present she complains of aching after a busy day on her feet or a long automobile ride.

*Examination:*

A healthy and vigorous young woman, twenty-four years of age; height, sixty-four inches; weight 148 pounds; of obese, short-necked type; with remarkably clear, fair skin; with a definite girdle obesity; long, tapering fingers; teeth not spaced. She walks with a peculiar stilted gait, making one think at once of a congenital dislocation of the hips.

Her pelvis is level; she has a marked head forward position, with shoulders drooping forward. The spine kinks sharply at the dorsolumbar junction and she has a marked lordosis. The right waist angle is more acute and she has a moderate left total curve. In Adam's position her spine is straight and her finger tips come within five inches of the floor. She has a moderate knock-knee, but very good foot statics.

The right thigh abducts thirty degrees and the left forty degrees. Outward rotation of both thighs is normal, inward rotation blocks at one-half of normal. The hip joint tests are all negative, as is Ely's test. Hyperextension of her spine is normal.

Her blood Wassermann is negative and her entire blood picture a normal one. The urinary findings are negative.



# TRAUMATIC UNILATERAL GENU VALGUM

## REPORT OF CASE

BY DENIS S. O'CONNOR, M.D., F.A.C.S., NEW HAVEN, CONNECTICUT

*Yale University School of Medicine, Department of Surgery*

The following case is reported because it illustrates a condition arising from trauma which is not always demonstrable by roentgenogram but may give rise to pathological development of a physiological process and result in deformities and disabilities.

J. R., three years of age, was seen in consultation on April 5, 1927, for a marked unilateral genu valgum and a peculiarity of gait. Five months before he had been injured when an automobile ran over the cart in which he was sitting. His specific injury was a fracture of the left tibia about four inches below the knee. The fracture was demonstrated by roentgenogram and a plaster-of-Paris cast was applied from the toes to the mid-thigh. Recovery was uneventful until the cast was removed when it was seen that the left leg was definitely deformed in valgus, a condition which did not exist to any noticeable degree before the injury. The attending surgeon considered the condition to be more apparent than real and manifested confidence that the condition would disappear when the child began to walk. When the child began to walk, the deformity was not only more noticeable, but the child walked in such a peculiar manner that he was referred to an orthopaedic surgeon for an opinion.

Examination showed a marked unilateral valgus deformity of the left knee and an increase of one-half inch in length in the affected leg. New roentgenograms showed good repair of the fracture with no evidence of deformity at the site of fracture.

From a consideration of the mechanism of the production of the fracture and its location, it was evident that the medial side of the upper tibial epiphysis had been separated with the concomitant hemorrhage into the structures about the epiphyseal growth cartilage. It is a well known fact which finds clinical application in the treatment of retarded growth in the long bones in anterior poliomyelitis that traumatic irritation of the epiphyseal growth disc will speed up the growth in the epiphysis. This was the most reasonable and only explanation for the condition found in this case.

The condition was treated by raising the sole and heel of the shoe on the unaffected leg to nearly compensate for the shortening. The inner border of the heel and sole of the shoe on the affected side was raised to invert the foot and the child was permitted to go about normally. At night the affected leg was encased in a plaster-of-Paris boot from the toes to the upper thigh. This boot was replaced frequently, each time correcting the knock-knee as much as possible.

After one year under treatment, at which time the patient was lost sight of, the discrepancy in the length of the two legs had decreased fifty per cent. and the knock-knee had become very much less noticeable.

# FOOT SUPPORT FOR USE WITH LEG TRACTION

BY CHARLES F. CLAYTON, M.D., FORT WORTH, TEXAS

Leg traction is useful in a variety of conditions. The problem of maintaining the foot in proper relationship to the leg during its use has long engaged the attention of those who have occasion to employ it.

Numerous attempts to solve this problem have been made, and some of the results published, but all, for one reason or another, have fallen short of meeting the requirements. Some months ago, with the idea of utilizing the traction force to provide the needed support, the apparatus shown in the accompanying illustrations was designed. The construction of this apparatus is shown in the perspective drawing, Fig. 1, and its application in Fig. 2. It will be seen to consist of three principal parts,—namely, frame, foot piece, and traction bail, the last two adjustably attached to the first.

In applying the apparatus the foot piece is set at the lowermost point on the frame, and adhesive strips of proper width and sufficient length to reach from ankle to knee are attached to its upper extremities. While an assistant holds the foot piece snugly against the sole of the foot and stretches the skin of

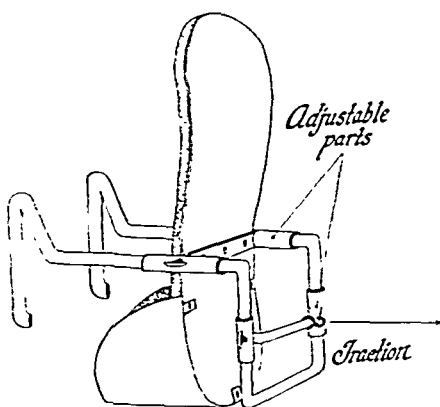


FIG. 1  
Showing details of construction.

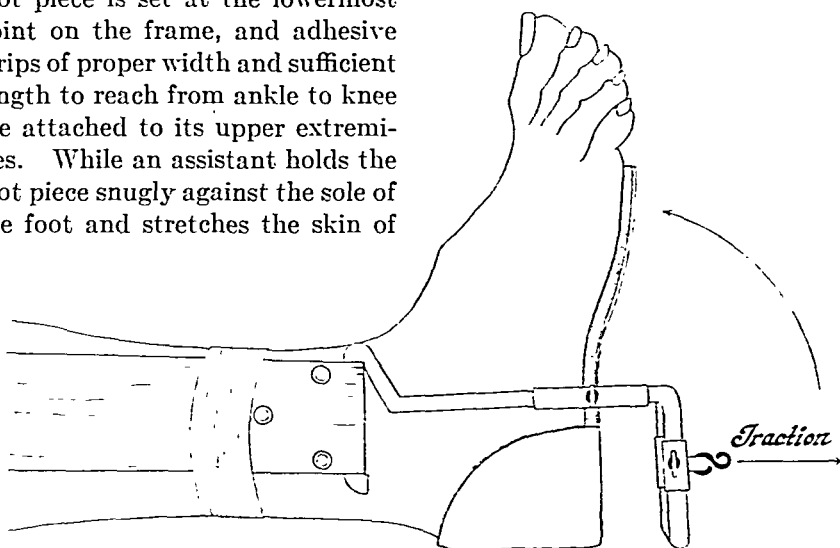


FIG. 2  
Apparatus applied, showing how tilting force is exerted to support foot.

the leg downward, the adhesive plaster is applied to the skin, and reinforced by circular strips and a temporary layer of gauze bandage. Traction of the required amount is then applied by means of pulley and weight. The traction bail is adjusted backward on the frame to a point where the exact amount of tilting force necessary to maintain the foot at a right angle to the leg is exerted. Continuous traction results in a gradual slipping downward of the adhesive plaster on the skin. Consequent loss of support is prevented by adjusting the foot piece upward on the frame from time to time, keeping it always in snug contact with the sole of the foot. Troublesome slipping of plaster at the points of attachment to the apparatus will occur unless it is secured in some manner. The use of small metal paper fasteners, inserted with an instrument made for the purpose, provides a neat, simple, and efficient means of accomplishing this (Fig. 2). When so secured, the plaster may in many instances be used for several weeks without renewal.

Experience in the use of this appliance has shown that it meets satisfactorily all of the requirements for which it was designed. It is simple in application, extremely comfortable and efficient, providing automatically adequate, continuous support for the foot.

## A DEVICE FOR THE RELIEF OF PAIN IN BURSITIS AT THE SHOULDER

BY ALBERT B. FERGUSON, M.D., NEW YORK, N. Y.

*Director of Roentgenology, New York Orthopaedic Dispensary and Hospital*

In many cases of bursitis at the shoulder, pain is lessened or relieved by downward traction on the arm. The device described offers a means of applying such traction without interfering with motion or occupational activity of the patient.

Sheet lead one-eighth of an inch thick is used as a weight. It is cut

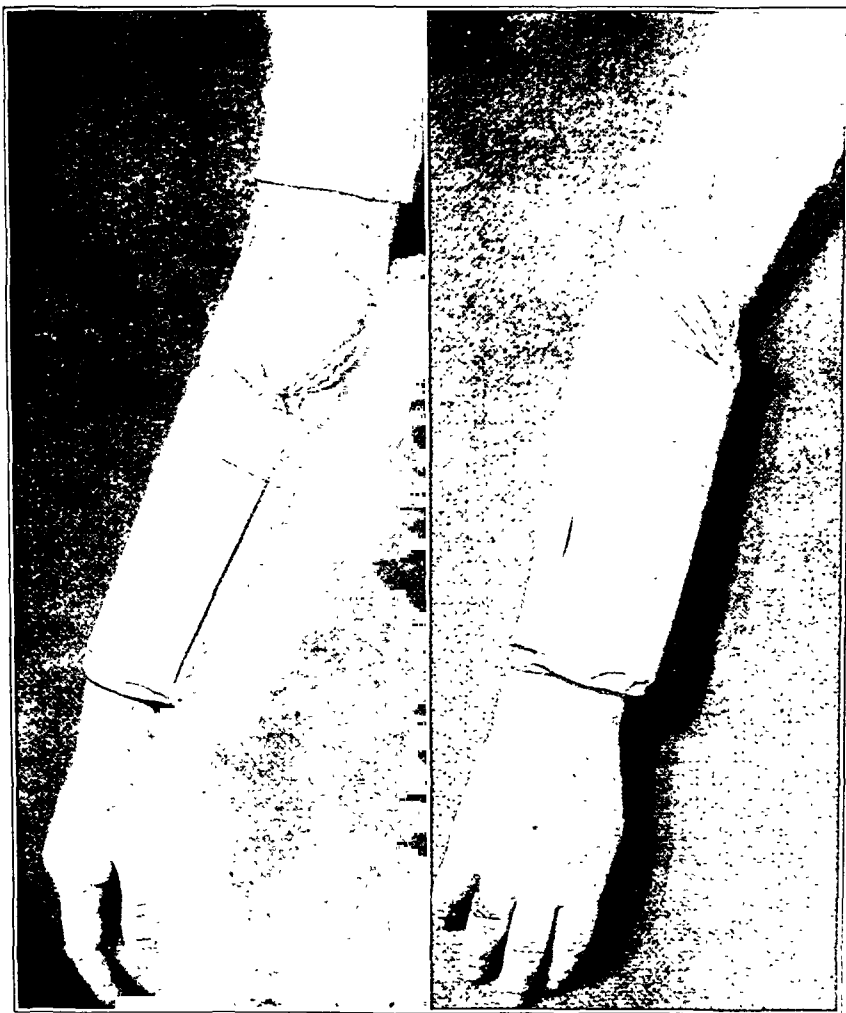


FIG. 1

six to eight inches long by two to six inches wide, the long axis fitting the circumference of the forearm near the elbow. About six by eight inches of lead (two pounds) is used for a patient who weighs 200 pounds, three by six inches (three-quarters of a pound) for a patient of 100 pounds. If the weight used causes fatigue, it is reduced about one-third after the first day.

The lead strip is bent over a three-inch pipe to form a tunnel. It is then covered with adhesive plaster to avoid soiling. A bandage is laid along the front of the forearm. The lead tunnel is applied over the bandage and pressed to fit the forearm snugly just below the elbow. The inferior end of the bandage is then brought up over the tunnel and knotted to the superior end. The free ends of the bandage are then passed about the arm just above the olecranon process and tied, not tightly. A strip of adhesive keeps the bandage from slipping over the olecranon process, which enables the bandage to hold the weight from slipping down the forearm. If the lead has been fitted snugly to the forearm it should not be necessary to encircle it with bandage.

This device is readily removed at night by slipping the knotted bandage over the olecranon process. It is easily reapplied by the patient. It gives quick relief and can be applied by the patient whenever pain occurs. It does not interfere with motion or with treatment of the condition by massage, diathermy, exercises, or other means. It has given great relief to the patients on whom it has been used.

The illustration shows the device applied. This is a large weight (six by six inches) and it has been padded with felt at the lower end to protect the radius.

## AN IMPROVED CLAVICLE SPLINT

BY MYRON O. HENRY, M.D., MINNEAPOLIS, MINNESOTA

The adjustable clavicle splint presented herewith has been devised by the author to fulfill the traditional requirements of lifting the shoulder upward and backward, and the modern requirements of holding the shoulder outward and permitting free motion of the joints of the arm during the healing period. This splint maintains the *elevation* of the shoulder through an adjustable upright taking its support from a pelvic girdle which is held well in over the crest of the ilium. Any desired amount of elevation can be secured and maintained by the set-screw. Only two sizes of pelvic girdles are necessary to adapt this splint to any adult and elevation of the shoulder is secured from the pelvis. A very thick axillary crutch is used with a pressure pad against the anterior portion of the shoulder. The *backward* position of the shoulder is then secured by a loop of webbing, which is passed around the other shoulder and can be drawn up to pull the shoulder backward as desired. The thick axillary crutch virtually increases the diameter of the cone of the thorax and thus maintains the shoulder in an *outward* position. The crutch is held close in the



FIG. 1

Side view of improved clavicle splint. Note *elevation* of shoulder by adjustable bar from pelvic girdle fitted over iliac crest, and *backward* position of shoulder.

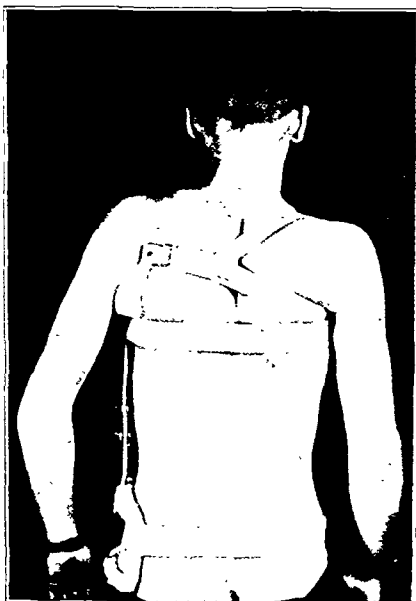


FIG. 2

Posterior view of improved clavicle splint. Note massive axillary pad maintaining *outward* position of shoulder, and strap to maintain *backward* position of shoulder.

apex of the axilla by a webbing strap about the chest at this level. The hand rest is attached to the upright by a set-screw, and can be set at any desired level.

The splint is not uncomfortable and it allows the patient to be ambulatory, fully dressed. Perfect alignment and correction of all shortening can easily be secured in this splint and the joints of the extremity remain entirely free throughout the healing period. The students whose fractured clavicles have been treated in this splint lost only one day from classes and gained perfect functional results. The free use of the arm permitted by this splint prevents atrophy and stiffness and thereby eliminates massage, physiotherapy, and other subsequent treatment.

Acromioclavicular dislocations, either complete or partial, can also be treated in this splint satisfactorily.



EMIL S. GEIST

### EMIL S. GEIST

Dr. Emil S. Geist died suddenly at his home in Minneapolis on May 14, 1933, of heart disease. He had just returned from the meeting of the American Orthopaedic Association in Washington, D. C. Mrs. Geist and one daughter were returning by motor. His death leaves a distinct gap in the ranks of orthopaedic surgeons.

Dr. Geist was born in St. Paul, Minnesota, on May 8, 1878. He was graduated from the Medical School of the University of Minnesota in 1900 and served his internship at St. Joseph's Hospital, St. Paul. He became interested in orthopaedic surgery and spent three years in post-graduate study abroad in the clinics of Paris, Breslau, and Vienna where he was associated with Mikulicz, Sauerbruch, and Lorenz. Upon his return he entered the practice of orthopaedic surgery in Minneapolis, where he practised actively until his death. He was early interested in the development of the x-ray and brought the first x-ray machine to Minneapolis. In 1911 he married Augusta Ohage, daughter of Dr. Justus Ohage of St. Paul.



His name will always be remembered in connection with orthopaedic surgery in the Northwest. He was the founder, and enjoyed being called the father, of the Minnesota Orthopaedic Society. He served as head of the Orthopaedic Department of the Minneapolis General Hospital for many years. He was a member of the active staff of all the private hospitals in Minneapolis, and in 1928 was elected president of the Hennepin County Medical Society. The Minnesota Academy of Medicine elected him President in 1931.

He was a Fellow of the American College of Surgeons and was a very active member of the American Orthopaedic Association. He was greatly interested in establishing an international society of orthopaedic surgeons and was a charter member of the International Society of Orthopaedic Surgery, founded in 1930 in Paris. He made many contributions to the scientific literature and was particularly interested in the progress of orthopaedic surgery.

During the World War he served with distinction and great loyalty as Major in the Medical Corps of the Army. During a part of this service he was assigned to the duty of conducting a school of orthopaedic surgery for younger officers at Fort Oglethorp, and made it one of the best in the service. He had also the capacity of infusing enthusiasm into all of his classes, which was shown by the voluntary testimonials given to him at the time of completion of the courses.

Dr. Geist had an unusually active mind and was interested in many things. He loved music, literature, and outdoor life, and his familiarity with several languages added much to his versatility, and the larger opportunity for contacts made possible by this accomplishment influenced his point of view to a wider vision and to a larger horizon.

His genial character and interesting personality attracted the attention of many young men to his chosen specialty, and he was constantly encouraging them to further study and pointing out problems to be solved. Wherever he was, he was surrounded by friends, the numbers of which bear witness to his nature.

# News Notes

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The Congress of the **Czechoslovakian Orthopaedic Society**, scheduled for next September, has been postponed until 1934. The members will endeavor to attend the Congress at Poznan, Poland, in which Congress all branches of medicine and surgery are represented.

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At the annual meeting of the **Milwaukee Orthopaedic Club** on April 21, Dr. Herman C. Schumm was elected President and Dr. L. D. Smith, Secretary.

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Prof. Jan Zahradníček has been appointed Director of the Clinic of Orthopaedic and Children's Surgery opened in Prague on May 3.

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Dr. Borivoje Gradojevič, formerly Assistant in the Clinic of Surgery, has been appointed Docent of Orthopaedic Surgery in the University of Belgrade, Yugoslavia.

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**Alumni Day of the Hospital for Joint Diseases** was held at the Hospital on Wednesday, May 3. An operating clinic and a dry clinic were presented by members of the Orthopaedic Service and by the staff of the General Surgical Service. Papers were also presented on "Diagnostic Observations on Some Abdominal Diseases" by Dr. Emanuel Libman, and "Present Day Trends in Orthopaedic Surgery in Light of Its Past History" by Dr. E. M. Bick.

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There has recently been established in Brno, Czechoslovakia, a new State Orthopaedic Hospital Clinic, attached to the University. This Clinic was opened on March 17 and is equipped with 119 beds. The Chief of the Clinic is Prof. Dr. Bedřich Frejka of Brno.

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At the opening of the new **Merck Research Laboratory** at Rahway, New Jersey, on April 25, the guest of honor was Sir Henry H. Dale, C.B.E., M.D., F.R.S., Director of the National Institute for Medical Research in London. Dr. Dale's address was on the subject "The Relation of Research in Universities to Research Supported by Industry".

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A hospital of 150 beds has been opened at Brno with complete modern equipment, under the auspices of the Laborers' Injury Insurance Institution of Moravia, with Dr. T. Novák as Director.

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The **Rocky Mountain Orthopaedic Club** held its regular meeting in Denver, Colorado, May 13, 1933, with Dr. Robert G. Packard presiding. The Rocky Mountain Orthopaedic Club was organized in September 1930 with the following members: Dr. S. Fosdick Jones, Dr. Robert G. Packard, Dr. Henry W. Wilcox, Dr. Atha Thomas, Dr. Charles Sevier, Dr. Hamilton I. Barnard, Dr. George K. Cotton, Dr. Melvin Black, of Denver, and Dr. J. Sims Norman of Pueblo. Meetings are held on the second Saturday of each month. Clinical cases are presented.

The preliminary program for the **Twenty-Eighth Congress of the Deutsche Orthopädische Gesellschaft** has been issued. The Congress will meet in Leipzig September 11 to 13, under the presidency of Prof. Dr. Fr. Schede. The principle subjects for discussion will be Orthopaedic Surgery and Rheumatism and The Conservative Treatment of Flat-Foot. Special consideration will be given to: (A) The Foot of the Small Child; (B) The Child at School and at Play; (C) The Foot of the Growing Child. Several papers will be presented on the various forms of arthritis. On the last day the members will present papers on various subjects.

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The **Fourth International Congress of Radiology** will be held in Zurich, under the presidency of Prof. H. R. Schinz, from July 24 to 31, 1934. According to the "Rules and Regulations", the Congress may be attended by: (1) members of radiological societies in all countries; (2) persons introduced by such societies.

At the general meeting the following subjects will be considered:

X-Ray Diagnosis of Bone Tumors.

Vasography.

The Development of Pulmonary Tuberculosis as Seen Radiologically.

Radiation Treatment of Uterus Carcinoma.

Radiation Treatment of Malignant Tumors of the Mouth and Pharynx.

Radiation Genetics.

Mitogenetic Radiation (*Mitogenetische Strahlung*).

Structure Analysis.

Identical Physical Measurement of the Dose in X-Ray and Radium Treatment.

Hard Gamma Rays, Cosmic Radiation, Earth Radiation.

Short Wave Therapy (*Kurzwellentherapie*).

All radiological societies are requested to send as soon as possible a list of their members to the General Secretary, Dr. H. E. Walther, Gloriastrasse 14, Zurich.

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At the Spring Meeting of the **British Orthopaedic Association** held at Cambridge on June 23 and 24, the program included the following lectures and demonstrations:

Factors in the Development of Skeletal Form. Dr. P. D. F. Murray.  
Experiments *in vitro* on the Histogenesis of Cartilage and Bone. Dr.

H. B. Fell.

The Repair *in vitro* of Embryonic Skeletal Rudiments after Experimental Injury. Dr. J. S. F. Niven.

The Development *in vivo* and *in vitro* of the Avian Patella. Dr. J. S. F. Niven.

The Control of Muscular Contractions by the Nervous System. Prof. Adrian.  
Experimental Deformities in Healthy Animals. Dr. A. B. Appleton.

Vitamins and Bone Structure. Dr. Leslie Harris.

Relation of Epiphyseal Ossification to Nutrition and Absolute Size. Dr. A. B. Appleton.

Mobility of the Abdominal Viscera. Dr. Barclay.

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The Second Congress of the **International Society of Orthopaedic Surgery** will be held in London, July 19 to 22, under the presidency of Prof. G. Nové-Josserand, of Lyon. The Secretary-General is Dr. J. Delchef, of Bruxelles. The meeting will be held at the headquarters of the Royal Society of Medicine, 1, Wimpole Street, London. The afternoon of July 19 will be given to the opening of the meeting and the general assembly of the members, and the evening to a reception by the President at the Langham Hotel, Portland Place.

On Thursday, July 20, the meeting will be opened by the President with an address on "The Orientation of Orthopaedic Surgery in General". Following this there will be

a discussion on "The Mechanism of the Joint Movements" by Dr. H. von Bayer, Heidelberg; Dr. Francesco Delitala, Venice; and Dr. Richard Scherb, Zurich. The afternoon will be devoted to clinical presentations and demonstrations in the hospitals, and the evening to a reception given by the College of Surgeons.

On Friday, July 21, "The Treatment of Tuberculous Coxitis" will be discussed by Dr. Philipp Erlacher, Graz; Dr. A. Maffei, Brussels; Dr. Melvin S. Henderson, Rochester, Minnesota; and Dr. Étienne Sorrel, Strasbourg. The afternoon will be occupied with operative demonstrations at the hospitals. In the evening a banquet will be held at the Dorchester Hotel, Park Lane.

On Saturday, July 22, the following subjects will be presented:

Arthroplasty of the Hip Joint. By Dr. Willis C. Campbell, Memphis, Tennessee.

Observations on Hypertrophic Osteopathies. By Dr. Charles Lasserre, Bordeaux.

Treatment of Fractures of the Spine. By Dr. Lorenz Böhler, Vienna.

A New Spinal Ankylosing Operation. By Dr. Fran Minář, Ljubljana.

Pathodynamics of Wrist and Finger Contractures. By Dr. Arthur Steindler, Iowa City, Iowa.

Arthrogryphus Multiple Congenita. By Dr. Walter G. Stern, Cleveland, Ohio.

Ganglionic Biopsy as a Means of Diagnosis in Tuberculous Osteo-Arthritis.  
By Dr. José Valls, Buenos Aires.

The Forty-Sixth Annual Meeting of the American Orthopaedic Association was held in Washington, May 8 to 11, under the presidency of Dr. Arthur Steindler. The clinical and scientific sessions were held at the Walter Reed General Hospital.

The first morning was occupied with clinical presentations by members of the Association in Washington and by members of the Staff of the Walter Reed General Hospital. After inspection of the Hospital, under the guidance of the Army Staff, the afternoon was open to the members and guests to occupy themselves at will.

The President's reception to members and guests was held at the Army and Navy Club on Monday evening, May 8.

On Tuesday, May 9, the following papers were presented:

Chronic Osteomyelitis Presenting Distinct Tumor Formation Simulating True Osteogenic Sarcoma.

Dr. George R. Elliott, New York, N. Y.  
Backache.

Dr. Joel E. Goldthwait, Boston, Massachusetts.

A New Operation for Recurrent Dislocation of the Jaw.

Dr. Leo Mayer, New York, N. Y.

Simple Method of Treatment of Many Metatarsal Disabilities.

Dr. J. T. Rugh, Philadelphia, Pennsylvania.

Sciatic and Sacro-Iliac Disease.

Dr. Albert Freiberg, Cincinnati, Ohio.

Prepondylolisthesis: Its Roentgenographic Appearances and Clinical Significance.

Dr. S. Kleinberg, New York, N. Y.

Data on Fracture Healing: Series of 2000 Rats.

Dr. Merrill K. Lindsay, New Haven, Connecticut.

Report on End Results of Tuberculous Joints.

Dr. Z. B. Adams, Boston, Massachusetts.

Original Features in Arthroplasty of the Elbow.

Dr. Fred H. Albee, New York, N. Y.

Presidential Address.

Dr. Arthur Steindler, Iowa City, Iowa.

Chronic Synovitis of the Knee with Persistent or Recurring Effusion and of Undetermined Etiology.

Dr. A. Bruce Gill and Dr. T. E. Orr, Philadelphia, Pennsylvania.

A Study of 100 Cases of Subdeltoid Bursitis.

Dr. Mark H. Rogers, Boston, Massachusetts.

Acute and Chronic Forms of Bursitis.

Dr. Charles E. Sevier, Denver, Colorado.

Fusion of Tuberculous Hips.

Dr. R. I. Harris, Toronto, Canada.

On Tuesday evening, a reception and address were given at Auditorium National Museum by the President of the Congress of American Physicians and Surgeons, Dr. Harvey Cushing, of Boston.

On Wednesday, May 10, the scientific session was continued at the Walter Reed General Hospital, and the following papers were presented:

Mechanical Instability of the Shoulder Joint: In Relation to Prevention and Treatment of Painful Shoulders.

Dr. Lloyd T. Brown and Dr. John J. Kuhns, Boston, Massachusetts.

The Relation of Blood Chemistry to the Locomotor System.

Dr. Russell M. Wilder, Rochester, Minnesota (by invitation).

Tendon Transplantations in the Upper Extremity in Cases of Poliomyelitis.

Dr. Frank R. Ober, Boston, Massachusetts.

Block Osteotomy for Bowed Femur.

Dr. Edwin W. Ryerson, Chicago, Illinois.

Description of Operative Procedure for Improvement of Cases with Quadriceps Paralysis.

Dr. C. C. Yount, Pittsburgh, Pennsylvania.

Pelvic Relaxation During Pregnancy.

Dr. Philip D. Wilson, Dr. D. Abrahamson, and Dr. S. Roberts, Boston, Massachusetts.

Transplantation of Astragalus and Carpal Navicular Bone.

Dr. D. B. Phemister and Dr. W. S. Keith, Chicago, Illinois.

A New Method of Osteotomy for Correction of Long Standing Bony Deformity at the Knee.

Dr. Armitage Whitman, New York, N. Y.

A Study of Torsional Deformity of the Lower Extremity with Special Regard to Etiology and Clinical Significance.

Dr. I. William Nachlas, Baltimore, Maryland.

On Thursday morning, May 11, the following papers were presented:

Nerve Injuries Associated with Fractures.

Dr. Dean Lewis, Baltimore, Maryland (by invitation).

Knee Joint Instability and Crucial Ligament Injury.

Dr. Arthur Krida, New York, N. Y.

Fractures of the Condyles of the Humerus.

Dr. J. S. Speed, Memphis, Tennessee.

Fracture of the Ulna with Dislocation of the Head of the Radius.

Dr. Samuel R. Cunningham, Oklahoma City, Oklahoma.

Treatment of Fracture of the Tibia and Fibula: Kirschner Wire Method.

Dr. C. F. Eikenbary, Seattle, Washington.

A Study of Old and Recent Fractures of the Ankle.

Dr. M. S. Henderson, Rochester, Minnesota.

On Wednesday afternoon the members participated in the General Assembly of the Congress of American Physicians and Surgeons.

The annual dinner for the members and guests of the Association was held in the Mayflower Hotel on Wednesday evening at eight o'clock.

At the business session, following the close of the scientific meeting, on Thursday, May 11, five orthopaedic surgeons were elected to membership:

R. C. Lonergan, M.D., Evanston, Illinois.  
E. B. Mumford, M.D., Indianapolis, Indiana.  
R. P. Schwartz, M.D., Rochester, New York.  
S. F. Stewart, M.D., Los Angeles, California.  
W. K. West, M.D., Oklahoma City, Oklahoma.

And the following were elected Corresponding Members of the Association:

Mr. H. A. T. Fairbank, London, England.  
Prof. René Froelich, Nancy, France.  
Prof. Patrik Haglund, Stockholm, Sweden.  
Prof. É. Sorrel, Strasbourg, France.  
Prof. Henning Waldenström, Stockholm, Sweden.

Two members were placed on the Emeritus List:

J. P. Lord, M.D., Omaha, Nebraska.  
Sydney Cone, M.D., Baltimore, Maryland.

The following officers were elected for the ensuing year:

President: Melvin S. Henderson, M.D., Rochester, Minnesota.  
President-Elect: DeForest P. Willard, M.D., Philadelphia, Pennsylvania.  
Vice-President: Arthur T. Legg, M.D., Boston, Massachusetts.  
Treasurer: John L. Porter, M.D., Evanston, Illinois.  
Secretary: Ralph K. Ghormley, M.D., Rochester, Minnesota.  
Executive Committee: Arthur Steindler, M.D., Iowa City, Iowa.  
Membership Committee: Robert I. Harris, M.D., Toronto, Canada.  
Program Committee: John C. Wilson, M.D., Los Angeles, California.

Delegates to the Congress of American Physicians and Surgeons: J. Torrance Rugh, Philadelphia, Pennsylvania. Alternate: Robert D. Schrock, M.D., Omaha, Nebraska.

Delegates to the American College of Surgeons: D. B. Phemister, M.D., Chicago, Illinois, David Silver, M.D., Pittsburgh, Pennsylvania, and W. B. Owen, M.D., Louisville, Kentucky.

The next meeting of the Association will be held in Rochester, Minnesota, under the presidency of Dr. Melvin S. Henderson.

# Current Literature

**SURGICAL ANATOMY.** By C. Latimer Callander, A.B., M.D., F.A.C.S. With a Foreword by Dean Lewis, M.D., Sc.D., LL.D., F.A.C.S. Philadelphia, W. B. Saunders Co., 1933. \$12.50.

This book, as the title implies, is a topographical anatomy, written from a surgical point of view, and represents in the main material which has been gathered from the original investigations of the authors. The anatomy has been studied definitely with the object of serving as an aid and guide in the surgical treatment of the affections of the various parts of the body. It is comprehensive, including all structures.

The authors make no attempt in this work to direct the surgeon in his treatment or in his technique, except to furnish him with anatomical data, particularly the topographical, anatomical data, which will serve not only in the details of operation, but in forming his judgment on procedures to undertake.

The book is divided regionally and with special consideration of the structure in each section, so that the information desired on any special anatomical structure or region can be easily and quickly found. The various approaches to the underlying structures are given without detail, but indicate by the description and illustrations the structures to be found in different steps of the operation, as well as those structures to be avoided. The position of the underlying parts is also described and indicated by illustrations which serve as a guide to the position and character of the incision for the special approach. The steps in these avenues of entrance are illustrated with excellent drawings, most of which are made from original dissections by the authors.

A great deal of attention has been paid to the discussion of the bones and joints with those anatomical considerations which are of interest because of their near relation to these structures and to the various portions which are known to be the sites of injury and disease. The different avenues of approach to these and the method of exposing the parts which are opened up are well illustrated, many times almost profusely so. The relation of the muscular structures to their tendinous attachments is given a great deal of attention and, aided by the photographs, serves to explain the mechanism of many of the distortions associated with fractures as well as many of the maladjustments often found in old cases. This portion of the book will be found particularly valuable by the orthopaedic and traumatic surgeons who occupy themselves with the affections and injuries both of the bones and joints, and the entire work will be a great aid to the surgeon of lesser experience and the means of refinement of technique to the more experienced surgeon.

**THE SIGNIFICANCE OF PHOSPHORIC ESTERS IN METABOLISM.** By Robert Robison, Ph.D., D.Sc., F.R.S. (Christian A. Herter Lectureship on Pathological Chemistry, New York University.) New York, The New York University Press, 1932. \$2.00.

This short monograph should be of interest and help to any practitioner of medicine who is interested in the physiology and pathology of bone and bone diseases.

The first chapter is rather technical and requires a certain knowledge of chemistry in order to thoroughly understand it. It concerns "The Occurrence of Phosphoric Esters in Nature". It illustrates how work in the fundamental sciences may at any time become applicable in furthering our knowledge of physiology.

The author was originally interested in the phosphoric esters of alcohol fermentation. In studying the hydrolysis of hexos monophosphate by various enzymes, he found that, when hydrolysis of soluble calcium salts occurred, the liberated inorganic phosphate was precipitated as the insoluble calcium phosphate on the side of the vessel. This finding suggested to the author that such a mechanism might be concerned with the

deposition of calcium salts in the bone. Further investigation proved that such a mechanism did occur in the calcification of cartilage and bone.

As a result of such well thought out and well controlled experimentation, we now know that the enzyme in bone and cartilage called phosphatase plays this all-important rôle in calcification. Methods for its determination in blood have been worked out and are being used in the clinic as a diagnostic procedure in differentiating bone diseases. The highest values are obtained in generalized osteitis fibrosa cystica, rickets, and Paget's disease.

Much of the experimental work presented was done by the author and his colleagues. Certainly this book should be read by every orthopaedic surgeon.

**PERIPHERAL NERVE INJURIES.** By Lewis J. Pollock, M.D., and Loyal Davis, M.D. New York, Paul B. Hoeber, Inc., 1933. \$10.00.

The authors have presented in this volume a very carefully prepared treatise on the subject of nerve injuries and their treatment, particularly the surgical aspect. The book confines itself to this special subject of injuries of peripheral nerves, but goes into great detail in all branches of the subject. The first thirteen chapters are devoted to the methods and means of examination of nerve injuries, as well as a description of the equipment which is necessary for such examination; one chapter deals with the development of the peripheral nervous system, particularly in its bearing on diagnosis and treatment. The next few chapters are devoted to pathological nerve lesions, degeneration of nerve, and methods of nerve repair, with full description of surgical technique, the various methods of suture, and the necessary after-care,—including exercises, etc., for the regeneration of nerves and muscular power.

The book then takes up the injury and treatment of the more important nerve trunks, treating each nerve in a separate chapter: its special injuries; the results of injury in distribution of the paralysis, both motor and sensory; deformity; methods of examination; and, particularly, the means and the technique of treatment. The trophic disturbances and the deformities following nerve injury are also considered.

The book presents the personal experience—evidently a large experience—of these two men, and, therefore, is largely individual, which adds to the value, but, as stated in its preface, the literature has been thoroughly consulted and the opinions of other observers have been used. For those having to deal with the very difficult subject of nerve repair, this volume will be found of great value.

**OPERATIVE SURGERY.** By Warren Stone Bickham, M.D., Phar.M., F.A.C.S., and Calvin Mason Smyth, Jr., B.S., M.D., F.A.C.A. Philadelphia and London, W. B. Saunders Co., Vol. VII, 1933. \$10.00.

As the result of an excellent plan, the seventh volume of *Operative Surgery* is issued, and gives, after the appearance of the first six volumes, recognition and opportunity for discussion of the many advances which have taken place during this time. In operative surgery these changes are largely confined to the opening of new fields for surgical procedures, and the development of new and important methods of technique in the already established procedures. By reference to the original volumes, this work is able to confine itself to the discussion of essentials of the more recent methods without entering too greatly into detail, which is unnecessary to that surgeon who is fitted for the surgical treatment of these conditions.

The changes in the technique and improved methods of general surgical procedure which have been developed in these latter years, many of which are the result of new and more accurate laboratory methods, are fully discussed. This is a valuable portion, for it is applicable to all departments of surgery.

The subject of anaesthesia, with new methods and improved technique, is given special consideration, which is wise, for anaesthesia has become a very important development in surgical procedures.



The enlargement of the field of bone and joint operative surgery, which has been made possible by the better understanding of those joint conditions shown by the x-ray, is given special attention in this book. Particularly is this evident in the treatment of fractures and the better results which are obtained because of the more accurate knowledge of the conditions with which the surgeon is dealing, and the facilities for observation during the course of healing.

The other departments of surgery have received in this volume the same careful treatment, confining the description to those methods which are more advanced and to which the experienced surgeon will naturally turn. It is a book which will be of much value even to those who do not possess the first six volumes.

**THE ADJUSTMENT OF MUSCULAR HABITS.** By Lieut. Col. James K. McConnel, D.S.O., M.C. London, H. K. Lewis and Co., Ltd., 1933. 4s. 6d. net.

This small book of 126 pages is rather an unusual presentation of the experience of an observer who has evidently had a large personal experience in the methods of physical training, physical adjustment, etc. The book is unique in many respects, particularly in its scope in dealing with this subject which ordinarily is more or less limited. The individual and his peculiarities, particularly the influence of old habit, are given consideration. The necessity of developing the proper spirit of cooperation, and the need for the careful study of the temperament of the individual, in every case, in order to obtain the best results are emphasized.

The term "adjustment", rather than "posture" or "malposition", is intelligently employed, and much more expresses the point of view and the method of attack which is advised by Mr. McConnel. The careful detail which is emphasized in treatment of these conditions, and the necessity for individual attention, may be followed with benefit by those engaged in these forms of therapy.

**AMERICAN AND CANADIAN HOSPITALS.** Edited by James Clark Fifield, with the cooperation of the American Hospital Association. Minneapolis, Midwest Publishers Company, 1933. \$10.00.

This large volume offers to the public valuable information in regard to hospitals in the United States and Canada. In this book practically all hospitals are listed, and the necessary information in regard to their foundation, size, equipment, standing, etc., is given, as well as the medical and surgical staffs and the relation to the community which they serve. In addition to this there is presented a list and an account of practically all the associations dealing with hospitals—social service, nursing, Red Cross, etc.—with a history of their organization and development, their official personnel, and the objectives to which they are devoted; also, as an appendix, is given in the same manner a list of the various associations, funds, foundations, etc., which are engaged in hospital and welfare service.

The book is a large one, composed of 1560 pages, confines the material to this practical information, and will be found of value as a reference book by all those who are in need of information of this character.

**REPORT ON THE STRANGWAYS COLLECTION OF RHEUMATOID JOINTS IN THE MUSEUM OF THE ROYAL COLLEGE OF SURGEONS.** By R. Lawford Knaggs, M.C. (Cantab.), F.R.C.S. Bristol, John Wright and Sons Ltd., 1933. (British J. Surg., XX, 113, July 1932; 309, Oct. 1932; 425, Jan. 1933.)

This report is a welcome contribution to do credit and honor to the unusual work which was begun and carried on by Dr. Strangeways in Cambridge. The assembling of this material was begun by this unusually intelligent and honest worker when the subject of arthritis offered little inducement, either in result or pecuniary reward, to the time and

effort spent in pursuit of this subject. This collection, which was the work of the larger part of his life, testifies to his foresight and to his enthusiasm. At the death of Dr. Strangeways, the Collection was given to the Royal College of Surgeons, under the care of Mr. Knaggs. The specimens have had a very thorough study by Mr. Knaggs, who now presents the results of this study in a form of great practical value to the student of arthritis.

The characteristics of the different types of arthritis are considered and the intimate relation between osteo-arthritis and rheumatoid arthritis as regards different phases or stages of the same infection is discussed; and also the conditions found in gout and the neuropathic changes are very thoroughly illustrated.

Four conclusions are drawn as to the factors causing the different rheumatoid conditions:

"1. The circulation of toxins is probably the essential and underlying factor in all four.

"2. The measure of the vitality of the joint tissues is shown by their resistance to the toxic influence, and is the deciding factor in the evolution of osteo-arthritis and rheumatoid arthritis.

"3. A metabolic factor is of decisive importance in gout; and

"4. A nervous factor in Charcot's disease, but in both these conditions toxins and tissue vitality take their full share."

**CHRONIC ARTHRITIS AND FIBROSITIS: DIAGNOSIS AND TREATMENT.** By Bernard Langdon Wyatt, M.D. Baltimore, William Wood and Co., 1933. \$3.50.

Following an introduction that recapitulates the mortality statistics in arthritic diseases, cites the influence of age, sex, etc., on its incidence and the effects of social conditions, geographic distribution, and morbidity figures upon the mortality, and discusses how important it is to the general practitioner that these diseases be recognized and treated by him, thus avoiding the danger of falling into the hands of incompetents, the author devotes a chapter to nomenclature, pathology, and etiology. The pathology is largely quoted from Dr. Allison's monograph. He adopts the same classification that he followed in his earlier book, except that he places gout among metabolic disturbances and devotes considerable space to a discussion of the various tests used in the study of chronic infectious arthritis to establish its allergic relations in the matter of treatment. Emphasis is laid upon diet and building up the patient's resistance. All forms of physiotherapy find a place in the author's armamentarium, including colonic irrigation, various electrical currents, air currents, water baths, and douches. Vaccine therapy comes in for discussion. In addition to the frankly arthritic lesions he includes a class which he designates as chronic fibrositis, to cover the near-arthritis, apparently. A good deal more detail is gone into in this book as far as treatments are concerned than in the former, with the result that the general impression is not so good. The appeal for a composite therapy savors too much of just the things that need to be avoided, which had no place in the earlier work.

**REPORT ON SIXTH INTERNATIONAL CONGRESS OF MILITARY MEDICINE AND PHARMACY—**  
The Hague, Netherlands, June 1931—Report of Commander William S. Bainbridge,  
M.C., U.S.N.R. Washington, United States Government Printing Office. \$1.00.

The official delegates, representing thirty different countries, who attended the Congress are listed; its officers and the members of the permanent committees are stated and the subjects decided upon for consideration at the Seventh Congress are set forth.

Subjects reported on at the Congress include:

1. Recruiting, Training and Advance Training of Military Medical Officers and Pharmacists.

This subject is reported on officially by some six leading nations, and the methods

carried out by each explained. Communications from leading medico-military men of various other nations on this subject are included, and a report after thorough personal study of these methods by two medical officers is made, conclusions drawn, and recommendations set forth.

2. The Psychoneuroses of War; The Immediate and Remote Effects of War on the Nervous System of Combatants and Non-Combatants.

The Congress recommended a neuropsychiatric center for the Army, for sorting, serious cases evacuated, retention in the Army area of others, a regional center in every region in the interior, for a second sorting and for classification; major psychopaths interned in asylums,—transitory disturbances to be treated there and patients requiring more prolonged treatment, in secondary regional centers.

3. Methods of Hemostasis on the Battlefield; Standardization of First-Aid Material and the Mode of Application.
4. Preparation and Storage of Medical Ampoules.
5. The Sequelae of War Wounds of the Teeth and Inferior Maxilla; Their Treatment.

Collaboration of a dental specialist and a surgeon are essential from the start. Initial immediate treatment and immobilization are essential. Bone infection is to be prevented by early extraction, debridement, and fixation. Non-union and loss of substance are treated by bone graft, malunion by osteotomy and correction of deformity. Metallic osteosynthesis is contra-indicated. Temporomaxillary ankylosis is treated by arthrotomy and mobilization apparatus. Scar excisions and plastic repair of soft tissues are indicated. The psychological state of the individual with a facial deformity should never be lost sight of.

*The Journal* wishes to acknowledge the receipt of the following publications sent to the Editorial Department:

Journal de Médecine de Bordeaux et du Sud-Ouest. Bordeaux, Vol. CX, Nos. 2 and 8, January 20, and March 20, 1933.

Bulletin of the National Tuberculosis Association. Vol. XIX, Nos. 1, 2, 3, 4, and 6, January, February, March, April, and June, 1933.

Norsk Magasin for Laegevidenskapen. Oslo, Norway, Vol. XCIV, Nos. 1, 2, 3, 4, 5, and 6, January, February, March, April, May, and June, 1933.

Programm des 48. Fortbildungskursus der Wiener Medizinischen Fakultät. Vienna, 1933.

The Johns Hopkins University Circular, School of Hygiene and Public Health, Catalogue and Announcements for 1933-34. New Series, 1933, No. 5. Baltimore, The Johns Hopkins Press, 1933.

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In commemoration of his sixtieth birthday, two large volumes (LXXI and LXXII) of the *Acta Chirurgica Scandinavica* were dedicated to Prof. Einar Key of Stockholm. Most of the seventy articles were contributed by Scandinavian friends and admirers. Such names as Payr, Sauerbruch, Eiselsberg, and Kirschner appear in the author's index, however, and there are several American contributors. The frontispiece of the first volume is an appropriate photograph of Prof. Key. In addition to the formal dedication there are numerous personal tributes in the papers themselves.

ÜBER SCHÄDEN AN DER EPIPHYSENFUGE BEI OPERATIVER BEHANDLUNG VON FRACTUREN AM UNTEREN HUMERUSENDE (Injuries of the Epiphysis with Operative Treatment of Fractures at the Distal End of the Humerus). Ernst Bergenfeldt. *Acta Chir. Scandinavica*, LXXI, 103, 1932.

Contrary to the view commonly expressed in the literature, a careful analysis of seventeen cases showed no growth disturbance of the distal end of the humerus, two to eleven years after nails had been driven through the epiphysis in the course of open reduction of fractures. In three cases there was premature synostosis. A varus position in six was attributed to imperfect reduction.—W. P. Blount, M.D., Milwaukee, Wisconsin.

STUDIEN ÜBER DIE GABELSPRENGUNG IM FUSSGELENK (Studies of Separation of the Ankle Mortise). Patrik Haglund. *Acta Chir. Scandinavica*, LXXI, 280, 1932.

Separation of the lower ends of the tibia and fibula may be diagnosed by x-ray if an exact technique is used. Rotation of as little as ten degrees will vitiate the reading. A simultaneous symmetrical exposure of both ankles, with the feet close together in slight internal rotation, gives the most accurate reading. The central ray must fall exactly perpendicular to a line between the ankle joints. Separation is fairly common in severe sprains and fractures. Fortunately it usually disappears under the proper treatment. Persistent separation leads to a flail joint, traumatic flat-foot, and considerable disability.—W. P. Blount, M.D., Milwaukee, Wisconsin.

DE LA TRANSPLANTATION D'UN FRAGMENT OSSEUX POUR REMÉDIER AUX LUXATIONS RÉCIDIVANTES DE L'ÉPAULE; CONSTATIONS ET RÉSULTATS OPÉRATOIRES (Transplantation of a Bone Graft for Recurrent Dislocation of the Shoulder). S. Hybinette. *Acta Chir. Scandinavica*, LXXI, 411, 1932.

On the basis of twenty-two cases operated upon, the writer emphasizes the importance of damage to the labrum glenoidale and rim of the glenoid, as well as to the joint capsule, in the causation of recurrent dislocation of the shoulder. A bone graft from the tibia or crest of the ilium was placed in a periosteal pocket close to the rim of the glenoid, where the latter had been damaged or the capsule torn. Fixation of the graft was by reefing the capsule over it. The arm was kept in a sling and during the third week gentle active motion started. There were no recurrences. In only two cases was the mobility of the joint reduced. Numerous photographs are submitted in proof of the excellence of the results.—W. P. Blount, M.D., Milwaukee, Wisconsin.

UEBER DIE HABITUELLE LUXATIO STERNOCLAVICULARIS UND EINE NEUE OPERATIVE BEHANDLUNGSMETHODE DERSELBEN (Habitual Sternoclavicular Dislocation and a New Method of Operative Treatment). Sten von Stapelmohr. *Acta Orthop. Scandinavica*, III, 1, 1932.

From the study of thirty-six cases—three his own, two unpublished cases supplied by Dr. Nilsson, and thirty-one from the literature—the writer classifies subluxations and dislocations of the clavicle on the sternum as presternal (common), suprasternal, and retrosternal; and as follows:

Congenital:—One proved case. Nine were claimed but not proved. Trauma at birth was not ruled out. (Eight classified below.)

Acquired:—Bilateral symmetrical luxations.

Six traumatic.

Ten spontaneous (doubtful congenital predisposition).

Unilateral luxations.

One traumatic.

Seventeen spontaneous (including slight trauma).

Except for the few congenital cases and unilateral traumatic cases, the age at which the dislocation was evident varied between eight and twenty years. Females predominated nineteen to eight.

Retrosternal and suprasternal dislocations should be manipulated into the presternal type of dislocation which often inconveniences the patient very little. If operation is necessary the disc should be freed from its sternal or clavicular attachment, removed, and the reduction of the joint temporarily maintained by steel pins. The articular disc is sewed over the anterior aspect of the joint as a permanent reenforcement. The method was used by the writer in a bilateral case in 1928.—W. P. Blount, M.D., Milwaukee, Wisconsin.

UEBER GONITIS INCERTAE CAUSAE INBESONDERE SYNOVITIS CHRONICA "SIMPLEX", UNTER BESONDERER BERÜCKSICHTIGUNG DES "RHEUMATISMUS TUBERCULOSUS-PONCET" UND FÄLLEN VON SYNOVITIS MIT AUSGESPROCHENER FLECKIGER ATROPHIE. Halfdan Sundt. *Acta Orthop. Scandinavica*, III, 97, 1932.

This second article by Dr. Sundt on the subject of chronic gonitis deals primarily with the non-tuberculous lesions, which comprised 115 (thirty-five per cent.) of 329 cases reported. In sixty-five of these no definite diagnosis was possible. In twenty-two cases, of which six were children, the disease was bilateral but syphilis was ruled out. In the thirty-five of these cases in which the knees were explored, no microscopic evidence of tuberculosis could be found. Clinically tuberculous or syphilitic synovitis, osteo-arthritis, and osteomyelitis were variously imitated. Trauma and infection are important etiological factors. In half of the cases there was a history of trauma. Focal infection of tonsils, teeth, ears, nose, skin, or intestinal tract probably plays an etiological rôle. In some cases, especially the bilateral involvement of females at puberty or the climacteric, there is a constitutional or endocrine factor.

The synovial changes seem to be primary and the osseous, secondary. The x-ray may reveal an extreme patchy atrophy of the bones without clinical variation from the general run of cases.

Conservative treatment, including removal of foci of infection, correction of endocrine dysfunction, and x-ray therapy, should be tried first, but synovectomy will occasionally be necessary. Ten of the eleven total synovectomies gave very good results. Partial synovectomy seems to have a beneficial effect.—W. P. Blount, M.D., Milwaukee, Wisconsin.

PROPHYLAKTISCHE KONTRACTURBEHANDLUNG (Prophylactic Treatment of Contractures). V. Rienke. *Acta Orthop. Scandinavica*, III, 262, 1932.

This comprehensive monograph on contractures comprises an historical and a physiological consideration of muscle tonus, an experimental study of functional and

organic contractures, and the description of a mobilizing apparatus with summaries of fifty-six cases in which it was used.

From the results of immobilizing the knee joints of guinea pigs and rabbits, the writer concludes that:

1. Functional contractures (those which disappear under anaesthesia) arise after immobilization for as short a time as half an hour.
2. Functional contractures disappear under anaesthesia but return after awakening.
3. Organic contracture may appear after two to three days of immobilization.
4. The duration of a contracture is not entirely relative to the duration of immobilization, but depends also on variations in the animals and the thoroughness of fixation.
5. Increase in tonus of a muscle is produced by fixation in the *relaxed* position.

Organic contractures are primarily due to muscle shortening and secondarily to capsular changes. The *irritation of function* is considered important in preventing them. Motion should be started on the first day, but it must not increase an existing inflammatory reaction, or cause pain or spasm. Apparatus must not interfere with dressing of wounds. To this end a worm gear operated by the patient has been adapted to the immobilization of infections, traumatic and postoperative joint conditions. Movement is so gradual as to be imperceptible to the patient. The application to various joints is described and illustrated by line drawings and case summaries.—W. P. Blount, M.D., Milwaukee, Wisconsin.

IDIOPATHIC OSTEOPSATHYROSIS. Lowell S. Goin. *Am. J. Cancer*, XVII, 668, Mar. 1933.

The author distinguishes three clinical entities,—osteogenesis imperfecta, hereditary osteopsathyrosis, and non-hereditary idiopathic osteopsathyrosis.

The first is characterized by imperfect development of membranous bones, the occurrence of intra-uterine fractures, a high degree of mortality, and frequent fractures of the cranial bones.

In idiopathic osteopsathyrosis the membranous bones are seldom if ever affected, fractures do not usually occur before the middle of the second year, and the patients do not die of the disease. In addition, the hereditary form of the disease presents the characteristic blue sclerae.

Various theories of the etiology of the conditions are reviewed, with the conclusion that none of them has been substantiated.

In addition to the extreme susceptibility to fractures, osteopsathyrosis is characterized by a typical shape of the head, which exhibits bilateral increase in diameter and unusual prominence of the frontal and occipital bones. There are also likely to be attacks of profuse sweating, and protruding abdomen is a typical feature. Fractures may occur in any of the bones, although the most common are the humerus and femur. The disease is self-limited, subsiding at about the time of puberty.

The roentgenographic findings are characteristic, with normal epiphyses and slender and irregular diaphyses, which have very thin cortices. Pathological examination of the bone confirms the thinness of the cortex, with imperfect haversian system and ill defined medulla.

In regard to treatment, the author recommends high calcium diet combined with viosterol or heliotherapy, accompanying careful treatment of the local fracture and protection from other fractures.

The author's series comprises eleven cases, one of which is reported in detail, and there are numerous photographs and roentgenograms illustrating typical deformities.—Grantley W. Taylor, M.D., Boston, Massachusetts

MULTIPLE MYELOMA. A Report of Four Cases. Ernest Scott, F. M. Stanton, and Mary Oliver. *Am. J. Cancer*, XVII, 682, Mar. 1933.

The authors review briefly the history of the disease and the etiological and clinical

features. No new data are brought forward on these subjects. There is a careful review of the microscopic characteristics of the tumor and a recapitulation of the various theories of histogenesis. They conclude that the tumor cell is a derivative of the reticular cell of the hemopoietic tissues. They have collected thirty recent cases from the literature to add to the group collected by Geschiekter and Copeland in 1928, and in addition report in detail, with photomicrographs, five cases from their own autopsy series.—*Grantley W. Taylor, M.D., Boston, Massachusetts.*

FAMILIAL MULTILOCLAR CYSTIC DISEASE OF THE JAWS. William A. Jones. *Am. J. Cancer*, XVII, 916, Apr. 1933.

The author reports the existence of multiple cystic tumors of the jaws in three children of one family, with photographs, roentgenograms, and photomicrographs of an enlarged lymph node removed for diagnosis. Evidence of the process became apparent toward the end of the second year, and was well established shortly thereafter. The condition in the oldest child (aged six) suggests that regression may be in process. In addition to the malformed jaws, with hard palpable masses and wide alveolar ridges, there are derangements in the dentition and extensive enlargements of the submaxillary lymph nodes. The roentgenograms show multiple circular translucent areas with bony septa. The lymph node sections show hyperplasia with fibrosis and focal collections of endothelial cells.—*Grantley W. Taylor, M.D., Boston, Massachusetts.*

THE RADIOSENSITIVENESS OF TUMORS DERIVED FROM CARTILAGE. Arthur U. Desjardins. *Am. J. Cancer*, XVIII, 15, May 1933.

The author again discusses the diagnostic importance of sensitivity to radiation therapy in bone tumors. He reports in detail a tumor of the femur in a young boy, which presented the onion-skin lamellar arrangement of new bone in the roentgenogram, considered typical of Ewing's tumor. Radiation therapy caused some temporary regression in the growth, less marked than that occurring in cases of Ewing's tumor. Subsequent amputation confirmed the diagnosis of osteogenic sarcoma, tending to differentiate toward cartilage. Another case, in which the tumor was apparently a chondroma of the pubis, was likewise benefited somewhat by radiation therapy. The author concludes that bone tumors derived from cartilage, in respect to their susceptibility to radiation, are intermediate between solitary endothelioma and osteogenic sarcoma.—*Grantley W. Taylor, M.D., Boston, Massachusetts*

EL TRATAMIENTO DE LAS OSTEOMIELITIS Y FRACTURAS COMPLICADAS POR EL METODO DE ORR (Orr's Treatment in Osteomyelitis and Compound Fractures). Alberto Inclán. *Anales de Cirugía* (Habana), IV, 321, 1932.

Prof. Inclán presents his conclusions drawn from five years' experience with Orr's method in the treatment of osteomyelitis and compound fractures. Of the ninety-six cases treated by this method, fifty-two were of chronic osteomyelitis; eleven of acute osteomyelitis and fourteen of old osteomyelitis, following compound fractures; seventeen of recent compound fractures; one of pyogenous arthritis; and one of an infected wound. The conclusions are as follows:

1. Orr's treatment is considered the method of choice for the treatment of infectious osteomyelitis and of compound fractures treated six hours or more after the trauma.

2. Healing time is diminished, thereby reducing pain and discomfort for the patient, saving time and supervision for the surgeon, and reducing the cost of material to the institution.

3. The marked change in the general condition of these patients and their rapid return to normal speaks clearly in favor of the attenuation of the virulence of the infecting bacteria and of the clinical sterilization of the wound.

4. Reinfections and sinus formation are exceptional when using this method.

5. Foul odor is the greatest inconvenience of this treatment, as it produces in some cases vomiting and anorexia. Even the addition of peruvian balsam to the vaselin did not modify the condition in the cases in which it was employed.

CHONDROMA OF THE INTERVERTEBRAL DISKS. B. J. Alpers, F. C. Grant, and J. C. Yaskin. *Ann. Surg.*, XCVII, 10, 1933.

Extensions of the intervertebral disc cartilages are of two types,—protrusions into the vertebral bodies, first described by Schmorl; and into the spinal canal, as first described by Stookey.

The authors in this paper report a case of intraspinal protrusion successfully operated upon and review thirty-five case reports in the literature; in forty-six per cent. the cervical vertebrae were involved, in thirty-seven per cent. the lumbar, and in seventeen per cent. the thoracic.

The cartilage projections vary in size from a pea to a bean, are usually attached to the intervertebral disc, are encapsulated and extradural. Trauma apparently plays an important rôle in their production. X-ray of the spine is negative.

The clinical picture varies with the location. The lumbar ventral chondroma gives rise to pain in the back, sciatic pain, muscle atrophy and weakness in muscles affected, loss of reflexes, and diminution or loss of sensation in segments affected. Subarachnoid block may or may not be present. Lipiodol injection is an aid in diagnosis in many cases.—N. T. Kirk, M.D., Major, U. S. Army Medical Corps.

POST-TRAUMATIC PAINFUL OSTEOPOROSIS. René Fontaine and Louis G. Herrmann. *Ann. Surg.*, XCVII, 26, 1933.

Bone atrophy associated with pain and vasomotor disturbances is considered true osteoporosis in contradistinction to the atrophy of disuse. The authors distinguish four clinical forms; (a) post-traumatic, (b) post-injections, (c) result of nervous disorders, and (d) dystrophic-ovarian dysfunction.

This paper is limited to consideration of the traumatic form which "is the direct result of hyperaemia produced by vasomotor changes that result from reflexes which originate in the traumatized area".

The condition is characterized by: loss of motor function and atrophy, limitation of joint motion, characteristic roentgenograms, vasomotor disturbance,—i.e., oedema, cyanosis, elevation of skin temperature, and great pain. The loss of function and pain are out of all proportion to the trauma inflicted or the signs of injury found. Immobilization does not relieve pain but often increases it.

The condition is most often seen in the flat bones of the carpus and tarsus, next most frequent in the epiphysis of metacarpals, metatarsals, and phalanges, either following slight trauma or secondary to fracture. It is rare after fracture of the diaphysis of the long bones, but much more frequent in periarticular and juxta-articular regions.

From the roentgenographic study three stages in the evolution of the disease are recognized,—the onset, the height of the disease, and the reorganization.

Periarterial sympathectomy is recommended and has been carried out at Leriche's clinic in all cases since 1924 with gratifying results.

Twenty-two case reports are included and roentgenogram reproductions illustrate the article.—N. T. Kirk, M.D., Major, U. S. Army Medical Corps.

SULLE DEVIAZIONI DEL SACRO NEL PIANO SAGITTALE (Sacrum acutum—sacrum arcuatum). [Deviations of the Sacrum in the Sagittal Plane (Sacrum Acutum—Sacrum Arcuatum).] A. Albanese. *Arch. di Ortop.*, XLVIII, 529, 1932.

Albanese describes six cases of deviation of the sacrum in the sagittal plane, a deformity improperly designated as psuedospondylolisthesis, but which also has been designated as "sacrum acutum" and "sacrum arcuatum". The author calls attention to



the asymmetry of the pelvis that accompanies the various deviations of the sacrum and which tends to confirm the congenital nature of the disease.

In two cases there was a history of trauma that probably had increased a congenital deviation resulting in painful symptoms.

The author discusses the etiology in detail and concludes that two types, a congenital and an acquired group, exist.

The treatment is conservative with physiotherapy and orthopaedic appliances. In the severe forms a fusion operation may be indicated.—*Peter A. Rosi, M.D., Chicago, Illinois.*

ZUR LÖSUNG DES PROBLEMS DER OPERATIVEN BEHANDLUNG UNBLUTIG NICHT EINRENKBARER ANGEBORENER HÜFTGELENKVERRENKUNGEN (Solution of the Problem of Operative Treatment of Congenital Dislocation of the Hip not Reducible by Bloodless Method). Friedrich Loeffler. *Arch. f. Klin. Chir.*, CLXXIII, 817, 1932.

In those cases of congenital dislocation of the hip which are irreducible by bloodless methods, the pelvitrochanteric muscles are no hindrance to reduction. The pelvifemoral muscles are contracted and cannot be stretched by ordinary means without tearing or even greater damage.

The operation consists of resecting a section of the femur in its upper portion and corresponding in length to the elevation of the head above the acetabulum. The technique of the operation is described.

The functional and cosmetic results are good. There is no limp or pain and movements are free. Lordosis is corrected. The shortening of the limb can be overcome by raising the shoe.

Several cases are briefly reported.—*R. J. Diltrich, M.D., Fort Scott, Kansas.*

A METHOD FOR THE PRODUCTION OF INCREASED COMPRESSION STRENGTH OF BONE: AN EXPERIMENTAL STUDY (Preliminary Report). Dudley Ross. *British J. Surg.*, XX, 337, 1932.

In the first series of experiments on dogs, a section of bone was removed from the tibia, the bone rongeuired into small fragments and the fragments replaced in the medullary cavity with the periosteum sutured over the defect. An Olsen testing machine was used to determine the compression strength of the repaired bone compared with the opposite tibia used as a control. It was found that four months were required for the bone to return to its former strength and that the presence of the bone fragments did not add extra strength.

In the second experiments a similar technique was used, but a detached strip of muscle was also inserted into the medullary canal. When the animals were destroyed, it was found that the muscle had disappeared, that new bone had formed in its place, that the compression strength had been increased. These experiments show that muscle tissue interposed between bone ends, provided it has lost its blood supply, becomes calcified and does not interfere with union at the usual time.

BIPARTITE CARPAL NAVICULAR BONE. G. I. Boyd. *British J. Surg.*, XX, 455, Jan. 1933.

It is important to remember that a congenital bipartite carpal navicular bone appears once in about a thousand persons. It is recognized by (1) absence of a history of injury, (2) the meagerness of the physical signs, and (3) the presence in the x-ray picture of a thin, well defined layer of compact bone covering the spongy bone. The other wrist is likely to show the same condition but does not always. This condition is of importance in compensation cases.

THE TREATMENT OF TUBERCULOUS DISEASE OF THE HIP-JOINT. A. S. Blundell Bankart. *British J. Surg.*, XX, 551, Apr. 1933.

This paper was read as the Presidential Address to the British Orthopaedic Association in July 1932.

A very large percentage of cases of tuberculosis of the hip joint are made latent when treated by conservative measures, only to become active later in life. While a tuberculous lesion of a joint is quite apt to be a metastatic infection from some other focus, the writer believes that it is justifiable to attack the local lesion in the joint at the same time that general hygienic treatment is being given for the lesion as a whole.

Pugh observed that tuberculosis of the hip joint begins in the inner portion of the ilium immediately above the acetabulum and spreads to the non-articular portion of the acetabulum, through the ligamentum teres to the head of the femur. The process is, then, tuberculosis of the pelvis and not of the hip joint. It is doubtful if operations tending to reduce motion in the hip joint will cure tuberculosis of the pelvis. The old type of excision of the hip did not attack the primary focus. Extra-articular fusion operations, which do not entail disarticulation of the head of the femur, prevent the ascent of the femur and closure of the tuberculous cavity formed by the destruction of the bone. Ankylosis of the hip is not a condition to be imposed on a patient if it can be avoided.

Tuberculous lesions of the spine, where the vertebrae are allowed to collapse and the abscess cavity is thus closed, give fairly good results except for the deformity. Bone graft operations prevent collapse of the vertebrae and obliteration of the cavity.

Nine cases of pelvic bone tuberculosis, quiescent for years, treated by removal of the local disease are reported. The results were so satisfactory that the author believes that early tuberculosis of the ilium should be attacked radically with the hope of eradicating the disease and preserving motion in the hip joint.

THE USE OF A MODIFIED DOUBLE THOMAS FRAME IN THE TREATMENT OF THE PARALYSES OF POLIOMYELITIS. Jean Macnamara. *British Med. J.*, II, 1098, 1932.

Dr. Macnamara describes a modification of the double Thomas frame designed to splint and relax the muscles of patients with extensive paralysis due to poliomyelitis. By means of the splint all four extremities can be kept at rest in the position of optimum relaxation of the paralyzed muscles. The abdominal muscles and trunk muscles are also splinted. The device seems of value in the care of the extensively paralyzed patient. Detailed directions for its construction are given.—*R. I. Harris, M.B., Toronto, Canada.*

THE TREATMENT OF RECENT INJURIES. W. E. Tucker. *British Med. J.*, I, 135, Jan. 1933.

Tucker contributes an article on the treatment of injuries,—chiefly contusions, sprains, and bruises received in sports. He advocates the somewhat unorthodox view that all such injuries should be treated with great vigor in order to "work out the bruise". He considers the early absorption of extravasated blood very important in order to prevent fibrosis and late disability. Treatment of a considerable variety of injuries is discussed in detail.—*R. I. Harris, M.B., Toronto, Canada.*

FRACTURES OF THE SHAFT OF THE FEMUR. W. J. Eastwood. *British Med. J.*, I, 359, Mar. 1933.

Eastwood records his experience in the treatment of sixty-one cases of simple fracture of the shaft of the femur by means of fixed traction in a Thomas splint with counter-traction against the ischial tuberosity. His recorded results are excellent. His article is in reality a plea for the use of the Thomas splint as incomparably superior to all other forms of traction and fixation; yet his own paper reveals the many features concerning the use of a Thomas splint which make it of doubtful value in most hospitals and in the hands of most surgeons.

His article leaves the impression that an enthusiastic surgeon aided by a perfect nursing staff can obtain excellent results by treating fractured femora with a Thomas splint. To credit the Thomas splint with the successful results is a mistake. They were

obtained by the unremitting and enthusiastic attention of surgeon and nurses. Similar enthusiasm and care would be rewarded by equal success, no matter what apparatus was used.

This article aroused a great deal of controversy in the correspondence columns of succeeding numbers of the *British Medical Journal*, several letters being written both for and against the use of the Thomas splint. It cannot be emphasized too strongly that fractures are never treated by apparatus. Each is an individual mechanical problem, and successful end results can only be obtained by intelligent personal supervision.

—R. I. Harris, M.B., Toronto, Canada.

EXPERIMENTELLE UNTERSUCHUNGEN ÜBER DIE GELENKRESORPTION UNTER VERSCHIEDENEN PHYSIKALISCHEN BEDINGUNGEN (Experimental Investigations on Absorption from Joints under Various Physical Conditions). W. Müller und H. J. Lauber. *Bruns' Beitr. z. Klin. Chir.*, CLV, 39, 1932.

The experiments were performed on dogs and consisted of the injection into the joints of small amounts of strontium bromid and subsequent examination by roentgenography to determine the rate of absorption. It was found that application of a tourniquet delayed the process of absorption greatly, but did not entirely arrest it. Hyperaemia, when applied after the injection, also delayed the absorption, but when used previous to the injection it hastened the process.

Mechanical compression of the joint, resection of the nerves to the joint, application of heat or cold to the joint, and inflammation of the joint did not produce any noticeable change in the rate of absorption. An increased rate of absorption was brought about by active movement of the joint and by massage.—R. J. Dittrich, M.D., Fort Scott, Kansas.

ZUR FRAGE DER SYNOVEKTOMIE BEI CHRONISCHEN UNSPEZIFISCHEN KNIEGELENKSERKRANKUNGEN (Synovectomy in Chronic Non-Specific Diseases of the Knee Joint). A. Läwen. *Bruns' Beitr. z. Klin. Chir.*, CLVI, 153, 1932.

After reviewing briefly the literature on this subject, the author considers the various technical procedures employed in this operation and the indications for this method of treatment. He feels that synovectomy is not frequently indicated and states that among ninety-eight arthrotomies, which he performed for non-specific diseases of the knee joint, there were only two synovectomies. In each of these cases the operation was employed for the purpose of relieving a simple chronic synovitis and involved only the anterior compartment of the knee joint.

The writer also calls attention to the operation of internal arthrotomy, which consists of the production of an opening between the synovial cavity and the periarticular tissues, and permits a continuous drainage from the joint cavity.—R. J. Dittrich, M.D., Fort Scott, Kansas.

LE FRATTURE DELLA CLAVICOLA (Fractures of the Clavicle). Giuseppe Rotolo. *Clin. Chir.*, VIII, 874, 1932.

Giuseppe Rotolo reports on a series of fractures of the clavicle treated in various clinics under the direction of Prof. Rossi at Milan. The report is based upon 342 fractures of the clavicle studied and treated from 1905 to 1931, but it is limited to twenty-seven fractures, chosen from among those it was possible to examine at a late date and including the various types.

Nineteen of the cases that were given in detail were treated by Bardenheuer's method of traction with weights, modified by Rossi. He gives a very clear description of the method which consists of keeping the patient recumbent for about fifteen days with the arm in abduction and supination. A Balkan frame is used with the arm supported in a hammock. Rotolo states that function rather than absolute anatomical reposition should be the measure of the result, but with the Bardenheuer-Rossi method anatomical reposition is also satisfactory.

In Rossi's clinics the experience with cases subjected to open reduction has not been good, and he quotes various authors who also have had unsuccessful results. Nevertheless he quotes a number of surgeons who recommend open operation as the treatment of choice.

The paper is well illustrated and the authorities well correlated. The illustrations alone give an excellent idea of the anatomy and physiology involved and also of the method advised.—*Murray S. Dmforth, M.D., Providence, R. I.*

ÜBER HALSWIRBELBRÜCHE (Fractures of the Cervical Spine). M. Laesecke. *Deutsche Ztschr. f. Chir.*, CCXXXVI, 329, 1932.

Ten cases are reported. The author advocates the utmost conservatism in treatment. Even in severe cases, with more or less marked injury to the spinal cord, conservative measures will produce a decided improvement, and not infrequently lead to conditions which are practically normal.—*R. J. Dittrich, M.D., Fort Scott, Kansas.*

SARKOM BEI OSTITIS DEFORMANS UND OSTEODYSTROPHIA FIBROSA (Sarcoma with Osteitis Deformans and Osteitis Fibrosa). R. Wanke. *Deutsche Ztschr. f. Chir.*, CCXXXVII, 198, 1932.

From a critical review of the literature and from personal observations the author concludes that osteitis deformans has a tendency to sarcomatous degeneration. The presarcomatous nature of osteitis deformans is especially evident in cases having a multilocular origin of sarcoma. Altogether, fifteen cases are reported in which osteitis deformans and sarcoma were associated. A statistical determination of the incidence of sarcoma on the basis of osteitis deformans cannot be made, because it is not possible to consider all cases of osteitis deformans as being free from sarcoma. Sarcoma occurs, indeed, in only a small percentage of cases; yet, when it is found, it is to be considered as a circumscribed or a diffuse sarcomatous degeneration of osteitis deformans. In this sense we can and may speak of a presarcomatous affection of osteitis deformans. However, with regard to the origin of sarcoma, other factors must play a rôle. Trauma can be considered only as a coincidence, as is proven especially in cases with multiple sarcoma.

Osteitis fibrosa, on the other hand, shows no tendency to sarcoma formation. From original observations and a review of the literature, the association of sarcoma with osteitis fibrosa can be conclusively proved only in exceptional instances. One case which the author previously reported as a sarcoma, on the basis of osteitis deformans, was on subsequent observation found to be a sarcoma associated with osteitis fibrosa. The remaining forty-one cases of localized osteitis fibrosa gave indications of the existence of the disease for periods of ten to twenty-seven years, and in cases of brown tumors (twenty-seven cases), all were under observation for more than five years, yet no other case was found to have sarcoma. The conception that osteitis fibrosa, like osteitis deformans, represents a presarcomatous condition cannot be upheld.—*R. J. Dittrich, M.D., Fort Scott, Kansas.*

ÜBER TRAUMATISCHE UND PATHOLOGISCHE QUERFORTSATZBRÜCHE DER LENDENWIRBELSÄULE (Traumatic and Pathological Fractures of the Transverse Processes of the Lumbar Spine). Max Ernst und Römmelt. *Deutsche Ztschr. f. Chir.*, CCXXXVII, 580, 1932.

The authors call attention to the controversies regarding incidence, recognition, methods of production, and treatment of this injury. This is followed by an analysis of fifty of their own cases.

A certain diagnosis can be made only by means of x-ray examination. This is made more difficult due to the large number of anatomical variations in the transverse process. Several different forms of anomalies are illustrated by diagram with descriptions of their characteristics.

Bony union occurs in only two-thirds of the cases of fracture; three to four months

are required for complete healing. Bony union did not occur in any case in which the fracture line was still noticeable four months after the injury. Small isolated fragments of bone may be detected in the soft tissues for years after separation from the rest of the vertebra. A failure of bony union is insignificant for future function.

Late symptoms are exceptional and may be produced by pressure of the fragment on the lumbar nerves.

The article includes a number of case reports with x-ray illustrations.—*R. J. Dittrich, M.D., Fort Scott, Kansas.*

BEITRAG ZUR SCHÄDIGUNG DER KNORPELBINNENSCHLEIMEN DER KnieGELENKE (Contribution to the Study of Injuries of Cartilages of the Knee Joint). Remmer Andreesen. *Deutsche Ztschr. f. Chir.*, CCXXXVII, 602, 1932.

From the study of 150 cases of injuries to the cartilages of the knee joint, the author gives an accurate and detailed description of the macroscopic and microscopic changes noted in the affected tissues. Regenerative changes are described as they occur in the separated meniscus and the capsular remains.

The ages of twenty-eight to thirty years are most favorable for such injuries.

Separation of the lateral portions of the meniscus is in most instances considered a pathological fracture, and brought about by previous changes in the meniscus several millimeters from the attachment. Clinically, a pathological fracture presents the same picture as a traumatic separation.

The numerous cases of serous effusion into the knee joint are explained by vascular changes. In a genuine traumatic separation bloody fluid is present as a rule.—*R. J. Dittrich, M.D., Fort Scott, Kansas.*

PERIARTHRITIS OF THE SHOULDER. An Analysis of Two Hundred Cases. James A. Dickson and Edward H. Crosby. *J. Am. Med. Assn.*, XCIX, 2252, 1932.

In an effort to elucidate the relationship of trauma, focal infection, and metabolic factors in the etiology of periarthritides of the shoulder and to determine the most efficacious treatment for that condition, the authors have analyzed a series of 200 cases. They prefer the term "periarthritides of the shoulder" rather than subacromial bursitis, subdeltoid bursitis, etc., since calcifications, torn tendons, etc., do not explain the whole pathological picture. Periarthritis is a distinct entity and presents a definite distinct clinical syndrome. There is always a limitation of abduction to about forty-five degrees and internal and external rotation is limited about fifty degrees, while forward and backward motions are perfectly free and painless.

The author's study shows that the presence of calcium demonstrated by the roentgenogram is no indication of the severity of the condition. Some roentgenograms of shoulders showed a calcified area present and the patient had no pain whatever. Others showed no calcification at all, yet the patients had very severe pain. The analysis shows that foci of infection and glandular dysfunction appear to be more important than trauma as etiological factors, although it is extremely difficult to evaluate their true significance. Calcium deposits are found in about the same percentage of cases, regardless of whether the etiological agent was attributable to metabolic, glandular, or infectious agents.

The treatment is divided into two phases, local and general. The general treatment consists of elimination of foci of infection, attention to the metabolic condition of the patient,—as, for example, whether they are hypothyroid or hyperthyroid types, whether they are potential diabetics, etc. Unless contra-indicated a low carbohydrate, high vitamin diet is usually prescribed.—*W. B. Carrell, M.D., Dallas, Texas.*

BILATERAL DISEASE OF THE INTERNAL CUNEIFORM BONE WITH AN ASSOCIATED DISEASE OF THE RIGHT SCAPHOID BONE (KÖHLER'S). Edward J. Haboush. *J. Am. Med. Assn.*, C, 41, 1933.

The author observes that there has been within recent years a greatly stimulated

interest in that peculiar set of disease conditions, such as Legg-Perthés' disease, Kienböck's disease, etc., and notes that most of the observations on the pathology of these several conditions seems to be an aseptic necrosis characterized by a fibrous infiltration of the bone extending in from the periosteum. He reports a case in which this disease process has involved the right scaphoid and both internal cuneiforms. This patient, a child of four and one-half, complained of pain in the left foot. Both feet were in severe pronation and there was a noticeable swelling along the inner border of the dorsum of the left foot. There was slight tenderness to pressure over the right internal cuneiform and scaphoid bones. Palpation of the left foot revealed local heat in the region of the swelling and pressure over the internal cuneiform was very painful. Right foot motions were free, while the left foot was held in eversion because of marked peroneal spasm. Inversion was painful. An x-ray showed that in the right foot the internal cuneiform and the scaphoid were affected, while in the left foot the internal cuneiform only was involved in this peculiar pathological process. A thorough search of the literature by the author failed to reveal a report of any such similar condition hence it was deemed worthy of report.—*W. B. Carrell, M.D., Dallas, Texas.*

**RUPTURES AND TEARS OF MUSCLES AND TENDONS OF THE LOWER EXTREMITY.** Report of Fifteen Cases. Edgar L. Gilcreest. *J. Am. Med. Assn.*, C, 153, 1933.

The author points out the paucity of literature on this subject and states that many cases of supposed sprain of a joint, arthritis, neuritis, etc., are in reality partial ruptures of certain tendons and muscle bellies. If these are diagnosed early and attended to properly by effective surgical interference, much quicker return to activity is accomplished and the end result is much better in practically all of the cases.

The tears occur most often in tendons or muscles which are fatigued or senile or have within them some pathological change, and it is usually an unexpected movement, bringing about a sudden powerful contraction of the muscle, that causes the tear to occur. Investigations have shown that the calf muscles come first in frequency, then the extensors of the leg, the biceps of the arm, the Achilles tendon and, last, the extensor of the thumb. Many cases of back pain or lumbago are in reality torn or partially ruptured fascial layers or muscles of the back.

The knee flexors that are most often ruptured are the semitendinous and the inner head of the gastrocnemius. The calf muscles, plantaris muscle, and the tendo achillis are also frequently injured, and the author discusses the findings to be expected in each case, with the additional presentation of several cases showing how this has happened in his patients and the results after operative repair.—*W. B. Carrell, M.D., Dallas, Texas.*

**THE PATHOLOGY OF MONOMELIC FLOWING HYPEROSTOSIS OR MELORHEOSTOSIS.** Ernest Kraft. *Radiology*, XX, 47, Jan. 1933.

This condition is a progressive hyperostosis, usually involving one side of the shaft of one or more of the bones of an extremity, non-malignant, and of unknown etiology. Nineteen cases are reported in the literature.

The hyperostosis may form a continuous flow, or appear as interrupted plaques: its appearance Leri compared to the molten stream of a candle. The disease is usually confined to a single extremity. The hyperostosis seems to follow the course of the vessels and nerves.

The gross appearance is that of sclerotic bone, and microscopic study bears out this resemblance. The joints are usually not involved.

The onset is slow, with vague rheumatic pains and bowing of the extremities in advanced cases. There may be mechanical interference with joint action. The disease begins in early life, but does not affect the general health.

Laboratory findings are negative and there is no known treatment. The disease may remain stationary for years.—*Edward N. Reed, Santa Monica, California.*

POSITIVE PRESSURE IN ARTHRODESIS OF THE KNEE JOINT. J. Albert Key. *Southern Med. J.*, XXV, 909, 1932.

On account of many failures to get firm bony ankylosis in arthodesing tuberculous knees, Key has devised this method: inverted U incision; complete excision of synovial membrane, semilunar cartilages, ligaments, etc.; cut off the condyles of femur, and of the tibia, and articular surface of patella with a saw. A heavy stainless steel pin is then drilled through the lower end of femur and another through the upper end of tibia so they are parallel. A small turnbuckle is fitted on each side and tightened enough to hold the bone ends firmly together. A snug plaster-of-Paris cast is applied from toes to groin. Tourniquet is then removed. A narrow window is cut out on each side to expose the turnbuckles which are then tightened so as to slightly bend the pins. Patient is put to bed with leg elevated. The turnbuckles are kept tight and the pins left in place eight weeks. If union is firm the pins are removed. Another snug cast is applied from toes to groin. Patient is allowed up on crutches, but no weight-bearing is permitted until sixteen weeks after operation. If there is any doubt about firm union a cast is again applied. Five cases in adults were so treated; four obtained solid union in an unusually short time; one died of sepsis. Two cases are reported in detail.—*F. G. Hodgson, M.D., Atlanta, Georgia.*

PROGRESSIVE PSEUDOHYPERTROPHIC MUSCULAR DYSTROPHY. Allen F. Voshell. *Southern Med. J.*, XXVI, 156, 1933.

The history, types, heredity, pathology, clinical features, chemistry, diagnosis, and prognosis are discussed. The recent methods of treatment by the injections of adrenalin and pilocarpin are considered. The author then presents statistical data of fourteen cases treated for six months or longer with glycine. Nine cases showed improvement of more or less degree. Five did not improve, one becoming worse. The younger the case, and the earlier the treatment is started, the better the prognosis. Active physiotherapy is given during the treatment. He suggests the combination of the adrenalin and pilocarpin treatment with injections of glycine. He advises against putting the patients to bed unless it is absolutely necessary.—*F. G. Hodgson, M.D., Atlanta, Georgia.*

OLD TRAUMATIC DISLOCATION OF THE HIP: WITH SPECIAL REFERENCE TO THE OPERATIVE TREATMENT. Leo J. Miltner, and F. E. Wan. *Surg. Gynec. Obstet.*, LVI, 84, 1933.

This rather uncommon condition has been encountered in sixteen cases reviewed by the writers. A discussion of the pathological anatomy is divided into posterior and anterior positions of the femoral head in relation to the acetabulum. In the former the capsule is torn postero-inferiorly and one or more of the small rotator muscles is torn, though occasionally the head passes between them. The Y ligament is intact and causes the typical position of flexion, adduction, and internal rotation. Contractures soon form and in three or four weeks the acetabulum is filled with adherent soft tissue. Changes in the femoral head are constantly present, often with considerable new bone formation.

Closed reduction may be attempted up to four weeks after injury with expectation of accomplishment, but after this time the open operation is preferable. The latter should be preceded by a period of skeletal traction. The operative technique is described, an approach by the Smith-Petersen incision being recommended. Complete reduction was accomplished in each case though the possibility of a shelf, resection, fusion, osteotomy, or bifurcation was discussed. Results are recorded as excellent in nine, good in one, fair in four, and poor in two cases. The serious complications encountered were infection (two cases), sciatic nerve injury (one case), and fracture of the femoral head during manipulation (one case).

Eighty per cent. showed markings of hypertrophic arthritis in follow-up roentgenograms, usually of mild nature clinically.—*Richard McGowney, M.D., Los Angeles, California.*

# The Journal of Bone and Joint Surgery

## A STUDY OF THE DEGENERATIVE CHANGES OF THE MENISCI OF THE KNEE JOINT, AND THE CLINICAL SIGNIFICANCE THEREOF\*†

BY MICHAEL S. BURMAN, M.D., AND CHARLES J. SUTRO, M.D., NEW YORK, N. Y.

### REVIEW OF LITERATURE

Relatively little has been written on the normal and pathological anatomy of the menisci of the knee joint. Mandl, among others, noted that there was definite formation of the menisci as early as the second month of foetal life. The development of the menisci has been studied recently by Dubinkin and Motnenko, who believe, as others have, that the meniscus is derived from the same mesoblastic tissues as the femur and tibia, but that the meniscal tissue becomes less well differentiated than the osseous tissue.

Ishido noted that in the new-born both menisci are broad and cover the entire tibial surface. We have observed the contrary in several babies born prematurely, in whom the menisci had their usual form and position. Mandl also noted that the form and position of the menisci of the new-born are like those of the adult. Both Ishido and he divide the meniscus of the new-born into three layers,—an outer vascular one, a middle zone, rich in fibers, and an inner cellular layer. The blood vessels are rich in the outer zone and penetrate to the middle zone, where the vessels course parallel to the fibers. The middle zone is free of vessels and contains coarse fibers which form an interlacing network. The inner zone is rich in nuclei and contains many cartilage cells arranged in groups, either encapsulated or sometimes with the suggestion of a capsule about them. At the anterior and posterior points of insertion of the menisci, the inner cellular layer is absent and blood vessels penetrate to the inner margin.

\* From the Laboratory Division of the Hospital for Joint Diseases, New York City: Dr. Henry L. Jaffe, Director.

† This work was first begun in the *Krankenhaus der Friedrichstadt-Dresden*, Dresden, Germany, through the kindness of Dr. G. Schmorl, and was continued and concluded in the Laboratory Division of the Hospital for Joint Diseases.



In the first few months of life, it is also pointed out by them, the width of the meniscus regresses, the inner zone diminishes, and the middle zone becomes coarser and more homogeneous. In the second year of life, with the assumption of erect posture and walking, there is a further alteration of structure. The ground substance or substantia of the middle layer shows wavy, interplaiting, homogeneous fibers. There is definite reduction of cell nuclei. The character of fibrocartilage is appearing. There is further reduction of the inner cellular layer and cell nuclei are in nest formation. At twelve to fifteen years of age, the typical appearance of fibrocartilage is present. Ishido noted that at this age there was a misproportion between the narrow blood-vessel lumen and its thick-walled coat, which shows fewer nuclei at this stage, as compared with the normal. The snow-white color of the meniscus of the suckling fades by this time and the meniscus becomes somewhat yellow.

Guibert and Grynfeldt studied the normal meniscus in commenting upon some pathological menisci removed at operation by Estor. They noted that the menisci are triangular on cross section and can be divided into two major layers, parameniscal and meniscal, the latter showing three zones. The parameniscal layer is composed of adipose and connective tissue, through which course vessels and nerves. The meniscal part is composed of fibrocartilage into which vessels from the parameniscal region penetrate radially up to the middle layer. Cartilage cells are most abundant in the middle layer. The inner layer contains no blood vessels.

We know of no particular work on the nerves of the meniscus, though their presence is frequently noted. The relation between pain sensitivity of the meniscus, especially in the locked position of the cartilage, and the presence of meniscal nerve fibers should be investigated.

The meniscus of the old cannot be differentiated from that of the young, according to Mandl. Nor is there any difference in structure between the external and internal menisci, though the former may, according to him, possibly have a larger blood supply. The nuclear richness of a meniscus in a particular period of life is individual and not characteristic of that period.

The work of Tobler on the changes in the menisci with advancing age forms a strong bridge between the normal anatomy of the meniscus and its pathological anatomy. Tobler examined 400 menisci from 100 cadavera of all ages. He described gross degenerative changes as appearing from the second decade on. White, shiny, circular, or spotty areas of "asbestos" degeneration are noted from then on, usually at each end of the meniscus or towards the outer middle part. They may be arranged in stripe formation and run through the entire meniscus lengthwise, and may even be found on the free inner edge. In older people, the white stripes become more yellowish. This "asbestos" degeneration is dependent on a degeneration of the fiber bundles. Irregularity of the free inner edge of the meniscus occurs with advancing age, often without

concomitant joint change. This irregularity may result in very jagged and torn inner edges.

The degenerative changes which occur in the meniscal substance are essentially the degenerative changes which occur in all connective tissues. Fatty infiltration is said by Tobler to occur in sixty-seven per cent. of cases, and begins at the age of fifteen. After the age of thirty-two, all menisci show more or less fatty changes, diffuse or irregularly arranged, and even in single fiber bundles. Cartilage cells undergo fatty changes regularly. Muroid degeneration is the next most frequent and occurs in fifty per cent. of cases, after the age of sixteen. It is regularly seen after the age of thirty-seven. Muroid degeneration does not usually express itself in a loosening and swelling of the ground substance, because of the thick and coarse character of the meniscal substance. The cartilage cells may remain intact for a long time in such areas of muroid degeneration, but these too may be destroyed. Similar changes may often be seen about vessels in the parameniscal tissues. "Asbestos" degeneration also occurs and expresses itself in fine fibrillation of the fibers, which become necrotic by molecular destruction. Hyalinization of the ground substance is present in thirty per cent. of all cases and is found mostly in the middle zone, though it may also be seen in the torn, frayed edge of the meniscus. Calcification is a secondary change and was observed in fifteen per cent. of the cases, the youngest specimen occurring in a cadaver sixteen years of age. The calcium is deposited as a fine dust at the site of a previously formed area of muroid or "asbestos" degeneration.

Other less important changes may occur. There may be overgrowth of cartilage cells, encapsulated or free, in diffuse or irregular masses. Oedema of the fiber bundles may occur in the inner middle zone near the insertion point of the meniscus. There may be a transition to hyaline cartilage, or even metaplasia to bone-like tissue. Elastic fibers in the fibrocartilage are few and may degenerate to fibrous tissue.

Pure degeneration is seldom seen after the age of seventy, according to Tobler. Predilection for degeneration occurs at the anterior and posterior insertion points, and in the arched middle, in the transition from the middle to the outer zone. These degenerative changes were also observed in operatively removed menisci, both in cases with and in those without a history of trauma. There may be a high degree of degeneration in a meniscus which has manifested few symptoms clinically.

Bircher examined seventy-four menisci of cadavera histologically, of which thirty were normal and forty were altered. The table of alterations cited by him follows:

- 24 showed arthritic changes.
- 15 showed new blood-vessel formation.
- 14 showed swelling and opacity.
- 8 showed infiltration.
- 8 showed necrosis.
- 9 showed meniscitis.

- 5 showed cell poverty.
- 4 showed nuclear poverty.
- 4 showed hyaline change.
- 3 showed poverty in blood vessels.
- 2 showed "asbestos" change.

A comparative series of 100 menisci operatively removed showed that more than one-half had undergone some degenerative change. The table follows:

1. No histological change.....	29 per cent.
2. Tears.....	23 per cent.
3. Connective-tissue change of cartilage.....	24 per cent.
4. Overgrowth of connective tissue.....	8 per cent.
5. Increase of cells of fibrocartilage.....	6 per cent.
6. Early organization.....	1 per cent.
7. Fibrin deposits.....	5 per cent.
8. Softening of cartilage and loss of nuclear staining.....	21 per cent.
9. Increase of fibroblasts.....	10 per cent.
10. Mucoid degeneration of cartilage.....	2 per cent.
11. Fibrinoid change.....	6 per cent.
12. Inflammation.....	5 per cent.
13. Increase of new blood vessels and new blood-vessel formation.....	22 per cent.
14. Fresh hemorrhage.....	8 per cent.
15. Hemosiderin deposits.....	23 per cent.
16. Calcification.....	3 per cent.

These changes are merely itemized in his work and not correlated.

Mandl examined thirty-eight of fifty-two operatively removed menisci. Of these, fifteen showed no disease process and twenty-three did. The author emphasizes that the pathological changes which he describes were never found in cadaver material, comparatively examined. A summary of the changes found in the twenty-three pathological menisci examined follows:

1. A round-cell infiltration about the vessels, the extent of this infiltration varying. The vessels were not limited to the outer layer, but penetrated even as far as the central layer.

2. Extensive areas of poor staining of the ground substance with absence of nuclei. This is most marked in the middle layer and is considered by him as an atrophic or necrotic process.

3. The presence of circumscribed or diffuse calcification of the ground substance as a degenerative change of high degree. This may occur either in the ground substance, usually as a fine dust, or in the capsule of cartilage cells, or in both.

4. Oedematous swelling of the ground substance.

Mandl arrives at the very fundamental conclusion that in cases in which there is a definite history of trauma there are no demonstrable pathological changes in the meniscus; and that in cases in which there is a history of no trauma, demonstrable changes are present. In the course of this work, we shall refute this statement.

Twelve out of thirteen operatively removed menisci, all with antecedent trauma, showed pathological changes, according to Thomsen of Kiel. He also pointed out the following histological findings in menisci which he examined,—round-cell infiltration with increase of capillaries and new fibroblastic growth, the formation of cystic spaces without endothelium, areas of ground substance in which no or few nuclei were present, areas of calcification, beginning and progressive fatty degeneration, and, finally, dissolving or breaking up of the capsules of cartilage cells. Baetzner, in two cases, noted marked degeneration of the ground substance, in part associated with fibrillation. There was also noted an increase in cells about increased and thickened blood vessels. An increase in long, spindle-shaped cells, closely packed together, was seen.

Röllgen examined menisci removed from young sportsmen and believes that meniscal tears are dependent on previous degenerative changes in the meniscus. He also noted certain changes in the vessels, consisting essentially of increase in number and of thickening of their walls. This was most marked at either end. In two cases, ossification of the meniscal ground substance occurred in part and true bone tissue was present. This must be a most unusual thing in man, since we have no record of any other such cases, save that of Lardys.\* Fisher noted that in marked mobility of the posterior end of the meniscus, marked hypertrophy and ossification might take place. In two cases, there was a metaplasia of the degenerated ground substance into hyaline cartilage. This also is an unusual change, distinguished not so much by its improbability as by its rarity. Röllgen suggests that possibly excessive demands on the knee, not necessarily of one great trauma but of repeated traumata, may lead to meniscal degeneration. He also suggests that changes in the blood vessels or changes in the synovial fluid may lead to degeneration.

Calcification of the meniscus is occasionally recognized by x-ray. Few cases have been reported and the situation is comparable to the occasional roentgenographic reports of calcinosis intervertebralis, before the work of Schmorl threw a panoramic vista on the pathology of the intervertebral discs. Calcification of the meniscus is secondary always to previous degeneration. Little calcification is seen usually, even in widespread degeneration. Israelski notes that calcification is usually bilateral, occurs past middle life, is unassociated with trauma and with arthritis deformans. About six cases have been reported, according to him. He quotes the findings in one case in which the cartilage was removed. A loss of cartilage cells with an excess of fibrous tissue and a diffuse infiltration with calcium was noted. One patient had gout and another

\* It seems not at all to be known that bone may be present as a normal constituent of the menisci of certain animals. Dr. Henry L. Jaffe recently demonstrated this fact before the New York Pathological Society. He showed that bone develops normally in the menisci of mice, guinea-pigs, and rats. His presentation may be found in the December 1932 Proceedings of the New York Pathological Society, published in *Archives of Pathology*, XV, 599, Apr. 1933.

diabetes; hence, Israelski believes in a metabolic significance of this condition. Symptoms may or may not be present. Werwarth, Bruchholz, Schwarz, and Meyer-Borstel have also reported cases, and the latter believes the process analogous to a beginning, ankylosing spondylarthritis.

Regeneration of the experimentally and clinically extirpated meniscus has been reported. Pfab noted the regeneration of the meniscus in sheep and in rabbits. The meniscus is reconstructed in the sheep in six months and in rabbits the process of regeneration has begun at six weeks. The meniscus is reconstructed from a synovial outgrowth between the femur and tibia, and, in one case in which its structure was examined histologically, it was found to consist of a thick, collagenous, connective tissue, fairly rich in blood vessels. Changes in the articular cartilage may accompany this regeneration in rabbits.

Sir Robert Jones noted that usually no trace of any new meniscal structure is found, even ten years after operation. Yet, in one case, three years after the removal of the meniscus for bucket-handle fracture, an almost normal meniscus was found on reoperation, the second operation being for loose body in the joint. If priority is to be given for the discovery of meniscal regeneration, he should receive it, since his observation precedes that of Mandl. Mandl noted this regeneration of the meniscus in four cases, in three of which reoperation was necessary for another condition and in one *post mortem*. That this regeneration of the meniscus is not necessarily advantageous is confirmed by the experience of Möller, who removed a regenerated meniscus which had become luxated. The new meniscus was a structure three to four millimeters broad, looked like a meniscus, was as hard as cartilage, and was properly placed. Microscopically, it consisted of a half sclerotic, lamellar, connective tissue, with vital nuclei. No sign of true cartilaginous tissue was present.

It may be the experience of a surgeon to find a meniscus *in situ* which had apparently been previously removed. Thus Fisher, who advocates the large exposure of the knee joint in operating for internal derangement of the knee, in one particular case noted that both menisci, previously considered removed through the usual small incision, were still present. This most probably is an instance of regeneration. Gibson comments on a similar experience.

Dieterich, Friedrich, Lukjanov and Pokrovski have also made clinical and experimental contributions on meniscal regeneration.

#### THE CLINICAL CORRELATION

Ishido committed a fallacy in asserting that the meniscal fibrocartilage takes part in diseases affecting the body proper,—such as uraemia, leukaemia, and endocarditis lenta. The changes described are simply the degenerative changes of progressive age, a fact which had not then been brought out. It is quite possible that in general septic processes the meniscus may be involved by metastasis. Thus he noted

purulent inflammation in the synovial part of the meniscus in thrombophlebitis, in grippe empyema, etc. There was purulent infiltration of the meniscus in a man, twenty-nine years old, dead of general sepsis, arising from a furuncle. Mandl noted extensive meniscal changes in diabetes, consisting of fibrillation of the ground substance, increase in vessels and cell nuclei, swelling of cartilage cells, and overgrowth of synovia. Again, before these changes are accepted as specific diabetic changes in the meniscus or even as a manifestation of a general diabetic change, the ever present factor of time degeneration must be ruled out.

More interesting is the observation of Ishido that in a woman of sixty-four, dead of arteriosclerosis, there was a marked degeneration of the ground substance and marked arteriosclerosis of the meniscal vessels. Henschen noted that meniscal vessels participated in diabetic vascular changes, indicating that these vessels might participate in severe sclerotic and degenerative changes of blood vessels.

Ohta noted that, after removal of the presacral ganglion, degeneration occurred in the meniscus.

The meniscus also, according to Ishido, was affected in joint changes. Thus he describes secondary degenerative changes of the meniscus in a joint affected with severe arthritis deformans, associated with tabes dorsalis. The severity of meniscal change corresponded to the severity of change on the femur surface. Heine, in an extensive monograph on arthritis, noted very briefly that the menisci and the crucial ligaments could also be involved by fibrillation and fragmentation. Müller pointed out that softening of cartilage takes place at points of pressure, where menisci or other intra-articular structures are placed. It is then quite possible that the effects of pressure on one will produce changes in the other. Fisher shows a meniscus involved in osteo-arthritis of the knee in which the posterior part of the meniscus is broadened and frayed. Mandl noted that, since the medial condyle of the femur is the most frequent site of arthritis of the knee, it is possible to see how changes in the internal meniscus might occur. Låwen has also observed this and has noted degeneration of the meniscus in primary chondropathy of the patella. In general, it may be said that there is a greater or lesser belief that meniscal changes may occur in arthritis.

We will not discuss inflammatory meniscal changes due to an associated joint lesion,—as tuberculosis, pyarthrosis, etc.

A condition which has attracted attention in France and Switzerland is the so called "traumatic meniscitis" of Roux. This was first described by Roux in 1895 and again in 1926, as a circumscribed thickening and inflammation of the outer and lower parts of the meniscal tissues, in the region of the lateral ligament, reaching to the anterior horn of the meniscus. This inflammation might pass over into the fat pads and produce Hoffa's disease as an end result. It is said to be really not an actual inflammation of meniscal substance itself, since it is a parameniscal inflammation, manifesting itself clinically as a meniscal lesion. It is

readily healed by conservative treatment, if no active lesion is present. According to Fisher, a thickened or fibrous semilunar fat pad may become attached to the meniscus by adhesions, the meniscus itself either being normal or showing changes. A contusion of the outer part of the meniscus, resulting in hemorrhage, may also occur. These changes may possibly be considered akin to the meniscitis of Roux.

Roux's syndrome, if it actually exists, has not received great support, since its character is indefinite. Many authors,—such as Pouzet, Bonnet, Philipoff, Steinmann, Estor, Patel, and Judet—have observed inflammatory changes in the meniscus. Bircher doubted whether the so called inflammatory changes deserved to be called "meniscitis", and reserved the term for those cases which showed actual inflammatory changes. Estor believed in a meniscitis on a non-traumatic basis and likened the meniscus to the avascular cornea as a seat of inflammation. Fründ was inclined to believe that small thickenings in removed menisci were inflammatory in origin. Najdanowitsch speaks of a true perimeniscitis. Mouchet and Tavernier, and Willems contest the definite presence of meniscitis.

A summary of the literature has indicated that the pathological anatomy of the menisci of the knee joint is a relatively unexplored field. This is surprising in view of the fact that meniscectomy is a standard procedure. The menisci of the knee joint, then, tend to undergo degeneration of various types. This degeneration is apparently greater with advancing age. The blood supply of the menisci is poor. Little attention has been given to changes in the blood supply of the menisci. Tobler and Ishido noted that vessel walls are relatively thick. A few observers have commented upon changes in the vessels.

#### GROSS EXAMINATION OF 200 MENISCI REMOVED FROM CADAVERA, OF WHICH 50 WERE EXAMINED MICROSCOPICALLY

Two hundred menisci from seventy-six cadavera were studied grossly. In all of these cases death was due to causes unassociated with primary joint disease, and, while it would not be fair to assume that no meniscal symptoms were present in life, still none of these cadavera presented any signs of previous operative interference in or about the knee joint. The menisci will be described by decade groups. The following table gives an analytic distribution of the specimens. In some cadavera, four menisci were removed; in others, three, two, or only one.

TABLE I

First decade.....	10 cadavera	26 menisci
Second decade.....	1 cadaver	2 menisci
Third decade.....	9 cadavera	25 menisci
Fourth decade.....	9 cadavera	27 menisci
Fifth decade.....	6 cadavera	14 menisci
Sixth decade.....	13 cadavera	34 menisci
Seventh decade.....	15 cadavera	39 menisci
Eighth decade.....	12 cadavera	30 menisci
Ninth decade.....	1 cadaver	3 menisci

It will be noted that more than half of the menisci examined are in the age groups of fifty to ninety years. This, however, will be counter-balanced by a study of the operatively removed menisci, in which the predominant age groups are from ten to forty years.

In the first decade of life, the menisci of three premature babies were examined, and showed normal form and position. Two full-term babies, a child of five months, and four children from two to six years of age were also examined. In all, the menisci were glistening, snowy white, smooth on both their upper (femoral) and lower (tibial) surfaces. The inner free edge was smooth and regular, and was slightly translucent. There was no gross sign of degeneration.

The one case in the second decade of life, a child of fifteen, showed a similar type of meniscus.

In the third decade, changes begin to appear. The external menisci of both knees, in an acromegalic cadaver, were abnormal in size and shape. The menisci were larger than normal and covered almost the entire lateral condyle of the tibia. The inner edge did not taper, but was pinkish, thick, and rolled up on itself, so that section of the meniscus was not triangular but oblong. There was a small projection from the rolled-up inner edge, near its center. The external meniscus tended to keep its C-shape. Interestingly enough, this peculiar meniscus was first observed through the arthroscope, before the joint was opened. The internal menisci of these knees were normal, though the inner edge of each was slightly irregular. Of the other menisci in this age group, it was noted that one meniscus showed a yellowing of its color, a change which becomes more frequent with advancing age. One meniscus showed marked fibrosis and "asbestos" degeneration of its ground substance. Thus, most of the twenty-five menisci were still normal grossly.

In the fourth decade, sixteen menisci were considered normal and eleven showed changes. The earliest change is one in color, a yellow or yellow brown being added to the normal white of the meniscus. There then appears a slight irregularity of the inner free edge, with diminution in its translucency. This irregularity may become a definite fraying. The surface of the meniscus becomes less smooth, even fuzzy and fibrillar, usually first on its upper or femoral surface. "Asbestos" change of varying degree may supervene and is indicated by the presence of silvery spots or stripes, usually at either end of the meniscus, or, at times, in the outer central portion. These changes were present in varying degree in the eleven menisci considered abnormal. Only one showed marked "asbestos" degeneration. This sequence of events in the alteration of a meniscus holds true for all other decades, though the changes occur in more marked degree.

In the fifth decade, the progression of degeneration continues. Of the fourteen menisci examined, two were normal; eight showed mild degenerative changes; and four showed marked alterations in appearance.

From the sixth decade on through the ninth decade, one no longer



sees menisci which may be considered normal, as compared with the early decades. In the sixth decade, mild changes were noted in eleven and advanced changes in twenty-three; in the seventh decade, slight changes were seen in six and more advanced alterations in thirty-three. In the eighth decade, advanced changes were seen in the thirty menisci examined. This was also true of the three menisci examined in the ninth decade. Arthritis of the knee occurs in increasing frequency in the periods just noted. In general, it may be stated from a study of nine definitely arthritic cadavera in this series that the degenerative changes run parallel to the degree of arthritis. There may be severe degeneration of the meniscus in the absence of arthritis or there may be severe arthritic changes in the presence of mild degenerative changes in the meniscus.

"Asbestos" degeneration becomes more marked in the later decades of life, so that in the severest cases the meniscus is merely a fold of silvery scar tissue interposed between the joint surfaces. This was noted very definitely once. Or the "asbestos" degeneration may be so marked at one end of the meniscus that it may become flattened, broadened, and loosened,—so much so that a foreign body might easily slip under the meniscus. Clinically, the slipping of a joint mouse under the meniscus has been reported by Geist. In no cases were fractures of the meniscal substance, either traumatic or pathological, observed, despite the very evident severe degeneration of many of these menisci. Joint mice were never noted, and in no case was a deposit of fibrin or blood noted on the meniscal surface.

Both the external and internal meniscus respond equally to the degenerative changes noted, and the greater frequency of injuries of the internal meniscus clinically can not be laid to this source. These pictures of advanced degeneration have been seldom noted in the living patient, since most of the operated cases fall in the younger groups. It may be possible, on gross examination, to place an excised meniscus in a particular period of life, though with no great exactitude.

#### MICROSCOPIC CHANGES IN THE MENISCI EXAMINED

Fifty of the menisci were examined microscopically and ten of these were stained with Mallory's elastic-tissue stain. Unfortunately, in the course of transportation and long storage of the specimens, after they had been grossly classified and described, there was a mix-up of the specimens, so that it was not possible to assign these menisci to their proper decade groups for microscopic examination. However, from their gross appearance, most of the specimens belonged to the later age groups. A few menisci of babies were included, as were also a few menisci in the earlier age groups. The menisci of babies will not be discussed in this paper.

All of the menisci showed degeneration of varying degree, both those that appeared grossly normal and the abnormal. Hyaline degeneration of the ground substance was most frequent. Oedema of the ground substance

was common in those menisci showing marked gross changes. Mucoid degeneration was also observed. The blood vessels in the vascular zone of the meniscus presented frequent alterations.

In order to simplify the description of pathological changes with regard to localization, two major meniscal zones are made out,—an outer vascular zone, and an inner avascular zone.

The blood vessels in the vascular zone presented many interesting appearances. Only the smaller vessels and capillaries usually showed changes and any large vessels that were seen were usually normal, though somewhat thick-walled. Occasionally the larger vessels also showed deviations from the normal. Hyalinization of the vessel walls of the small vessels and capillaries with frequent consequent fibrosis was seen fairly often. Thrombosis of the small vessels with organization was uncommonly observed. An eccentric intimal thickening was observed at times in the smaller, and occasionally in the larger vessels. The smooth intimal lining was seldom eroded or ulcerated. Elastic tissue was not demonstrable by ordinary stain. The Mallory elastic-tissue stain showed fragmentation of the inner elastic layer in the larger vessels at times. No elastic tissue was demonstrated in the smaller vessels. Vacuolization of the cells of the intima and of the middle coat was sometimes seen. No calcification of vessel wall was noted. An aggregation of small lymphocytes in the region of a vessel was seldom seen. Plasma cells were very rarely present. No evidence of inflammation was seen in any of the menisci examined.

Two major changes were noted in the ground substance of the menisci examined: oedema of the ground substance, expressing itself in fine fibrillation and loosening of the substantia; and, secondly, hyalinization of the ground substance. These two degenerative changes went hand in hand. This dissolving of the matrix by oedema was most marked in the interior of the meniscus. Small and great gaps were thus sometimes formed in the substantia, appearing as irregular intrameniscal cysts without lining. These spaces rarely resembled true cysts, for they were lined by smooth meniscal fibers in which flattened fibroblasts and cartilage cells were seen. These cystic spaces are not revealed by gross examination and Mandl has termed them intrameniscal cysts. The periphery of the meniscus was less degenerated and this was due to the anatomical arrangement of the fibers. The peripheral fibers run parallel to the synovial border and are gathered fairly thickly. As the interior of the meniscus is reached, obliquely running fibers are noted connecting bundles cut either transversely or longitudinally, forming a looser mesh than at the periphery. The external configuration of the meniscus need not be disturbed by extensive degeneration within its substance. The junction of the avascular and vascular areas was also the site of great fragmentation of the ground substance.

Mucoid degeneration was seen fairly frequently. Calcification of the ground substance was rare, and was always small and scattered.

There was no tendency to organize the degenerating areas, although near the area of synovial reflection a small invasion of fibroblasts and vessels occasionally took place.

In the outer vascular zone there was seen a variable amount of fat surrounding blood vessels and cross-cut fibers of the ground substance. Fat was not seen in the inner zone in any specimen.

As the synovial lining of the meniscus is continued over both surfaces of the meniscus, it loses its cellular quality and becomes a narrow, faintly staining, pinkish membrane, which shows faint traces of cellular structure. The point of transition into a single flat layer occurs at the level of synovial reflection. The membrane was often torn, irregular, and jagged. A deposit of fibrin or mucin on its surface was uncommonly seen and only once was a small hemorrhage noted. Cellular debris was not uncommonly seen on its surface.

Cartilage cells, normally usually arranged in small groups, lost their group arrangement by disintegration of their constituent cells in areas of degeneration. Nothing was left at times of the original cartilage cell. The fusion of spaces originally occupied by cartilage cells created small, irregular, cyst-like areas. This degeneration of cartilage cells was often wide-spread and was most pronounced in the middle of the avascular zone. No regeneration of cartilage cells, and no regional hypertrophy of cells, expressed by increased nest formation, was seen.

#### A MICROSCOPIC STUDY OF 85 SURGICALLY REMOVED MENISCI

Microscopic examination was made of the menisci of eighty-five patients in varying age groups. Surgical removal of the internal or external meniscus, or both, was done by various members of the staff of the Hospital for Joint Diseases. Decade distribution of cases is tabulated.

TABLE II

<i>Decade</i>	<i>Cases</i>	<i>Male</i>	<i>Female</i>	<i>Trauma</i>	<i>No Trauma</i>
Second.....	17	11	6	16	1
Third.....	31	22	9	29	1
					(and 1 with questionable onset)
Fourth.....	20	13	7	18	2
Fifth.....	11	8	3	9	2
Sixth.....	4	2	2	2	2
Seventh.....	2	1	1	2	0

The changes which were observed were again degenerative, though it was noted that mucoid degeneration was present to a larger degree than oedema of the ground substance, as compared with the cadaver material. Degeneration in a particular case was never pure.

The earliest change which took place was degeneration of the ground substance in the middle of the avascular zone of the meniscus. The subsynovial fibers, peripherally located, remained normal longest. Mucoid change, detected by its characteristic reaction, usually did not

result in the formation of clear, mucoid spaces. Cartilage cells often retained their form in an area of mucoid degeneration. Mucin was noted at times on the surface of the cartilage. The presence of mucoid areas in the outer vascular part occurred concurrently with that in the avascular parts. The significance of mucoid degeneration of the ground substance will be discussed more fully in the pathogenesis of meniscal cysts. \*

Oedema of the ground substance was less frequent and less extensive and was usually localized. Hyalinization of the ground substance occurred very frequently and was often accompanied by nuclear death, with fragmentation and pyknosis of nuclei. Anaemic necrosis of the ground substance was relatively common in the avascular zone. It was always combined with other changes.

The ground substance seldom underwent such extreme fragmentation and vacuolization that intrameniscal cysts were formed.

Fragmentation of the inner edge of the meniscus occurred often, so that it became irregular. At times, polypoid formation of the inner edge was present. The synovial layer over the meniscus was often broken up and in no case presented well defined cells. The synovial layer was narrow and usually hyalinized, though very seldom it extended as a cellular layer with subsynovial capillaries over the outer two-thirds of the meniscus. The débris on the surface of the meniscus consisted of cellular detritus, red cells, and small lymphocytes at times. Occasionally, an area of hemorrhage was noted in the ground substance or on the surface of the meniscus.

The cells in the matrix presented various changes. They might remain unaltered in the presence of a frankly degenerated or necrotic area. The cells which preserved their vitality the longest were those at the apex of the cross-cut meniscus and those at the periphery. Cells occasionally were clustered in nests, usually in groups of four to eight. Large clusters of cells were not observed. Nuclear death and the loss of cell and capsule occurred at times in areas of necrosis and degeneration. The fusion of many spaces created by the washing out of cells and capsules resulted in small intrameniscal spaces.

The point of greatest weakness in the meniscus was the junction of the vascular and avascular parts. Fragmentation may be so marked here that there may be separation of the two parts from each other.

The outer vascular layer presented a varying amount of cross-cut meniscal fibers, which underwent a lesser degeneration.

A few unusual observations were also noted. In a man in whom the internal meniscus had been previously removed, a pennant-shaped structure was seen at the site of the removed meniscus by arthroscopy and by arthrotomy. This may have been a regenerating meniscus, though we cannot be too certain of this. In another case, a hard calcified mass had developed at the site of the removed meniscus, in intimate contact with the tibia. This was noted at reoperation, when, in attempting to remove the posterior remaining fragment of the meniscus, it was found to end in this

mass of calcified tissue. Another meniscus is said to have been congested at its inner border; this must be considered a most unusual observation, since the meniscus is absolutely avascular at this point. Microscopic examination of this meniscus showed no signs of congestion.

The synovia showed frequent changes, consisting of hyperplasia of varying degree, congestion of subsynovial capillaries with a varying amount of lymphocytic infiltration, and occasional vessel alteration, as hyalinization.

The blood vessels of the meniscus again presented changes, similar to those seen in the cadaver specimens. Capillaries and small arterioles were primarily affected; the larger vessels were only occasionally involved. A focal collection of small lymphocytes was rarely seen about the vessels. Plasma cells were observed once or twice. A hemorrhage was seldom seen. About some capillaries there occasionally occurred a loose, concentric collection of young fibroblasts. The vessels in the removed infrapatellar fat pad often showed the same changes.

These vessel changes were present at all ages and were even noted in marked degree in the meniscus of a boy of ten. Regressive vessel changes are often found in certain organs such as the uterus and spleen. Yet, it must not be forgotten that these are organs of great vascularity and a disturbance of part of their blood supply does not affect the organ greatly. The meniscus, on the other hand, is relatively avascular and these vessel changes may be sufficient to disturb it. We do not mean to infer that the vessel changes are the direct cause of meniscal degeneration. These vessel changes are usually present in the presence of degeneration, though this is not always so. In general, the degree of vascular change runs parallel with the degree of meniscal degenerative change. Occasionally, vessel changes exceed the degenerative changes. The fibrosis and hyalinization of the vessels is evidently a regional phenomenon, since it often takes place in individuals otherwise healthy as regards the vascular system. It may of course participate in extensive, general, vascular change, and this was noted by Ishido and Henschen. In one of our cases, a patient in the seventh decade group, Mönckeberg's medial sclerosis was noted in a large meniscal vessel.

The vessels are intimately related to the process of repair in a meniscal fracture. Many fractures must undoubtedly occur with subclinical symptoms; or, with recurrence of locking and pain, a new fracture is created, macroscopic or microscopic, which may be healed by scar tissue if removal of the meniscus is not done. The healing, to be exact, is usually present in the vascular zone and in the outer avascular zone. Vessels never penetrate deeply into the ground substance. The capacity for healing of the meniscus is limited and this is often proven clinically. Fisher has demonstrated this experimentally. Yet, exsection of a limited piece of meniscus may result in regeneration, as shown by Dieterich. Healing occurs by the invasion into a fractured area of newly formed capillaries and young fibroblasts, which extend cord-like or stripe-like into

the gap. Maturity of vessels and cells takes place and scar tissue is formed, which is slightly vascular. The vessels in an area of such repair may undergo extensive thickening and hyalinization.

These degenerative changes of the meniscus are then present at all ages. It seems to us that the term "*meniscosis*" expresses best these degenerative changes, rather than the indefinite "*meniscopathy*".

One cannot place a meniscus in a definite age period by microscopic examination of a particular meniscus. Practically all menisci examined showed degeneration; only one or two did not. We also agree with Mandl that the nuclear content of the meniscus is individual. The amount of degeneration usually runs parallel with the duration of symptoms and questionably with the number of recurrences. It cannot be taken for granted, however, that degeneration begins with the original trauma. Thus, a meniscus with a very brief period of trauma may show advanced changes, even at so early an age as ten; or a meniscus, subjected to trauma of three years' duration and more than eighty attacks of locking, may remain relatively normal. It is quite probable that the degenerative changes in the meniscus are entirely independent of the original acute trauma, although degeneration may be hastened by it. Again, the stage of repair in a meniscus may be older than the clinical history, indicating previous subclinical fracture. The detached fragments of the meniscus, as in a bucket-handle fracture, often show degeneration, and these should not be neglected in the study of the meniscus.

It is interesting to speculate just why degeneration is so frequent in the menisci of the knee and apparently so rare in similar fibrocartilages,—such as the intra-articular meniscus of the temporomandibular joint. We examined the surgically removed meniscus of the jaw in one case; it was normal in structure. Baecker has recently examined the menisci of the jaw in six cases, and despite the relative avascularity of the tissue, normal cells and fibers were present, even in the old. Little has been written on this and further study should be carried on. Weight-bearing must condition meniscal degeneration, since this degeneration is also noted so commonly in the intervertebral discs. These are also composed of white fibrocartilage which regularly regresses with advancing age.

Meniscitis is never present. It is true that occasionally small round-cell infiltration is present about the smaller vessels, but this is never extensive and is confined to the outer part of the vascular zone. The synovial lining and the fat pads do show a true inflammation and, probably, the slight infiltrations noted in the meniscus are extensions of the synovial process. Meniscitis does not exist as a primary entity and the conception of Roux, unsupported by clinical or microscopic evidence, cannot be accepted.

#### THE PATHOGENESIS OF MENISCAL CYSTS

Meniscal cysts, once considered rare, are being reported with increasing frequency. From a review of the literature and a detailed

microscopic study of eight cases, we believe that meniscal cysts are degenerative in origin.

Two cases in the fourth decade of life showed a somewhat different anatomical association than is usual with meniscal cysts. One was a yellow, irregular tumor, placed under the biceps femoris tendon, surrounding the external lateral ligament of the knee joint. It was definitely connected with the external meniscus. From its yellow color and irregular shape, an operative diagnosis of xanthoma was made. The tumor and a portion of the meniscus were resected. Microscopically, this tumor was definitely a cyst. The other case in this age group presented intimate association of the cyst with the external lateral ligament.

The youngest patient in this series was eleven years old and the oldest thirty-nine. Most belonged in the usual age group of twenty-five to thirty years. Of the eight cases, six were cysts of the external meniscus and two of the internal meniscus. Of the latter, one has been previously reported by Zadek and Jaffe.

The gross characteristics of meniscal cysts will not be described, since they have been so well described by other authors. That type of cyst which is definitely parameniscal must be considered in a separate group. Fisher has pointed out that a bursa may sometimes be present at the anterior edge of the internal lateral ligament, in close connection with the internal meniscus, and that this bursa is a more common finding in anthropoid apes. Sir Robert Jones, in a footnote on this observation, said that he had removed two such cysts clinically and that they were not attached to the meniscus. Small cystic spaces are occasionally found in the parameniscal tissues, according to Jaffe, and it is possible that larger, palpable cysts may originate from them.

In the literature on meniscal cysts, two cases have been reported which are definitely parameniscal cysts. The first case of Zäch-Christen was of a cyst in definite connection with the external meniscus but easily shelled out from it. A meniscal cyst is a cyst which is an integral part of the meniscus and cannot be shelled out properly from the meniscus. In this case, the meniscus was left untouched. Microscopically, the cyst consisted of smaller cysts of various sizes, sharply outlined or not clearly demarcated, and lined by connective tissue. The second case was that of Krapf, who also described a small tumor placed between the external lateral ligament and the ligamentum capitis fibulae, definitely adherent to the joint capsule, but not to the external meniscus. The tumor was easily removed and the external meniscus was left intact. The tumor consisted of connective tissue, much like that of meniscal fibrocartilage, in which mucoid changes were taking place. The connective tissue as yet greatly exceeded the cystic, mucoid areas.

The microscopic feature of any meniscal cyst is a focal area of mucoid

and in the vascular part. This change is, of course, greatest in the vascular zone. Focal oedema plays a part, albeit a minor one. In the inner avascular zone, the mucoid changes are less loose, more diffuse and adhesive, and there is less often the tendency to focal formation, though this, however, does occur. The outer avascular zone often shows large cystic spaces due to the inward spread of the cyst from the vascular zone. The fact that this mucoid change takes place is not unusual, since it is a frequent form of degeneration in the meniscus. The motions of the femoral condyles will not allow the formation of cysts of appreciable size in the inner avascular zone, since pressure tends to squeeze all mucoid areas outward and toward the center of the meniscus. This explains the typical location of the cysts in the external meniscus. The larger formation of cysts in the vascular zone is due to the looser character of the tissue, which allows cystic expansion. Mucoid changes, never uncommon in the vascular zone, are of a looser, less adhesive character. It is not necessary to assume that this mucoid change is a secretory phenomenon. In a tissue in which mucoid change is regularly seen, it is unnecessary to assume specific functions of secretion as the cause of cyst formation.

The confluence of small cysts creates larger ones. Septa are found in a large cyst, indicating the lines of division of its constituent smaller cysts. The cysts may be distended or collapsed and, when large, contain usually only a mucoid débris in which no cellular structure is visible. The smaller cysts often show a myxomatous content, in part or in whole. Few typical, branching star cells are present.

The walls of the cysts are never endothelial. They are always formed of meniscal fibers, sometimes so altered that a smooth lining is formed. In the larger cysts, the walls are smooth and are formed by flattened and compressed meniscal fibers, in which spindle-shaped fibroblasts may be seen. These cells are not necessarily on the surface of the cyst, and King has proven this definitely by the use of silver stains which stain meniscal fibers but not endothelium. The cells lining the cyst may become so flat that a lining which superficially resembles endothelium is formed. This lining is never complete. The lining of the cyst may become a hyalinized membrane, staining a light pink, in which no cells are found. This has also been seen by Zäch-Christen. Or there may be an increase of cells at some particular point in the lining, so that a layer of cells, two to three deep, may be formed. The outer cells of these are always typically fibroblasts, and as the inner cells are approached, they become rounder or more oval. Villous processes may project into the cysts but these are never typical synovial villi. They are solid, cord-like, relatively avascular, and partially divide the cyst. The cells of these villi are essentially those round or oval cells described above. They form a smooth lining on the surface. Venezian depicted one such villus in an illustration accompanying his paper. A dissecting process of the meniscal fibers may be noted about the cysts, due to either mucoid or



oedematous change. This is a method of cyst progression and is not uncommon. It is a surprising thing to find many normal meniscal fibers about the cysts, so that a cursory examination might lead one to expect slight changes of the meniscal ground substance.

Marked degeneration of the ground substance of the meniscus was present in every case. This degeneration is mainly mucoid, and other forms of degeneration are also present. Focal mucoid cysts occur at times in the avascular part, as previously noted. This tells us why meniscal cysts recur after the removal of the cysts alone. The degeneration which creates the cyst is still present and the meniscus must be removed to prevent recurrence. It should be pointed out that many authors have reported normal menisci in conjunction with meniscal cysts. This has not been our experience.

It has been noted by others that cysts do not occur with fracture or dislocation of the meniscus. This is not true, and a meniscal cyst may be associated with a meniscal fracture caused by typical trauma. This was noted in two cases in this series and has also been pointed out by Zäch-Christen.

The vessels about the cystic areas have attracted some attention. Many observers have noted normal vessels. Quite frequently, thickening of the small vessels with hyalinization, with occasional intimal thickening and thickening of the middle coat, have been reported. Phemister believed these vessel changes secondary and not the cause of the cystic change. In all our meniscal cysts, we note the typical vessel changes described previously both in the menisci of the cadaver and in those surgically removed. One may occasionally see a small lymphocytic infiltration about the vessels; plasma cells are rarely present. Hemorrhage is seen at times in or near the cysts.

A synovial inclusion was once seen in the outermost part of the vascular zone. This undoubtedly does not represent a cyst, but merely the adhesion of several villi. A peculiar whorl-like arrangement of meniscal fibers in the region of cysts was observed once, so that in that area complete cysts could not be formed.

It is interesting to speculate why meniscal cysts are present in greatest degree in one particular age group and why the external meniscus is more often involved. The age group in which cysts occur does not show any greater predilection for mucoid degeneration than other age groups, nor does it exceed other age groups in this. The comparative rarity of meniscal cysts is explained by the fact that only a small percentage of menisci undergoing mucoid degeneration undergo focal cystic change. It may be that the age group of twenty-five to thirty years is the first to show changes and that, if cysts are to be formed, they will be formed in this age group first. It may be objected that cysts should occur at a later age and in fact they do, even being reported at fifty-five years of age.

Its greater localization in the external meniscus is evidently due to a dynamic and an anatomical factor, since it is known that internal and

external menisci degenerate to an equal degree. Physiological knock-knee has been assumed as a factor. Fisher has noted that at the outer mid-part of the external meniscus there is a covering of synovia which separates the tendon of the popliteus from the meniscus, and that it is at this point that meniscal cyst develops. The external lateral ligament is not as intimately connected with the external meniscus as is the internal lateral ligament with the internal meniscus. It may be thus that the factor of growth spread of the cyst may account for its greater frequency in the external meniscus. This would infer that focal cystic formation occurred equally in both menisci and that the cyst could not spread in the internal meniscus. Whether or not this is true is uncertain.

Sex involves only the differential factor of trauma which we believe important in the genesis of the cyst, but not of the degeneration of the meniscus itself. Thus, a greater frequency is noted in men and our series comprised only men. If the factor of physiological knock-knee is important, it should be the more so in women.

#### A NOTE ON TUMORS (PSEUDOTUMORS) OF THE MENISCUS

Tumors of the menisci are rare, much rarer than cysts, and may occur in conjunction with meniscal cysts. Von Brunn first reported a fibroma of the meniscus in 1907. Zäch-Christen reported a giant-celled, xanthomatous tumor on the surface of a meniscal cyst. Tobler also reported a xanthoma arising from the internal meniscus. Kott has recently described a fibrous tumor of the meniscus, in structure very similar to that of the meniscus. These tumors may undergo cystic degeneration as noted in the case reported by Serafini, and in the case mentioned by us. Both the internal and external menisci are equally involved and the menisci appears grossly normal. Microscopic examination of the meniscus removed in Zäch-Christen's case showed a normal meniscus. Both sexes are equally affected. The age group in which meniscal tumors appear is in general like that of meniscal cysts. The symptomatology of tumor of the meniscus is essentially like that of cysts. Tumor of the meniscus is not to be confused with meniscal cyst, parameniscal cyst, palpable bursa about the knee joint, and free joint body.

The origin of these tumors is as yet not clear. The so called fibroma with a structure like that of the meniscus suggests an origin from the meniscal substance itself. It is unlikely that a detached piece of the meniscus would grow so as to form a large and definite body connected with it. A case reported by Entschö Dimoff as a rupture of the internal meniscus in a man of thirty-one, occasioned by typical trauma, revealed at operation a flattened, oblong structure, arising from the meniscal surface at its middle, and swinging forward and downward medially to overlap the inner edge of the meniscus. The lamellar flap was easily removed and the meniscus left intact. The author attributed this peculiar appearance to a tear of the superficial lamellae of the meniscus. The inward displacement of the flap caused typical locking. A case such as this resembles very

strongly those cases diagnosed as fibroma of the meniscus and suggests the traumatic origin of this so called tumor. If this manner of origin is true, then these are merely pseudotumors and not true tumors. The normal appearance of the meniscus in these cases may be accounted for by the regeneration of the surface tear occasioning this tumor.

The xanthomatous tumors are apparently associated with a high blood cholesterin, as in the case of Züch-Christen, in which the blood cholesterin, taken a year after the resection of the cyst and tumor, was 200 milligrams per 100 cubic centimeters of blood. We know nothing of the deposition of cholesterin crystals in the menisci of the knee joint. That menisci may participate in disorders of metabolism, such as gout, was pointed out by Ishido. Yet the changes, in so far as described by him, are not specific as previously noted. Xanthomata are usually not considered as true tumors. Since no other types of tumor of the meniscus have been described, and since malignant tumors of the meniscus do not occur, it is perhaps preferable to consider these as pseudotumors, rather than true tumors.\*

Recurrence has not been noted after removal of the tumor.

In the case of a man of thirty-seven, a mass, one by three by four centimeters, covered by a thin fibrous capsule, was attached by a tendinous pedicle to the middle of the outer margin of the internal meniscus.

Examination of the mass showed marked degeneration of the ground substance which very closely resembled the ground substance of the meniscus. Muroid degeneration was marked and small focal cysts were present in many areas. The walls of these cysts were degenerated ground substance. There was marked hemorrhage throughout the substance of the tumor. A thickened but torn synovial lining was present, on which some lymphocytes and red cells were present. The meniscus itself was apparently not sectioned. A diagnosis of a necrotic, pedunculated fibroma, attached to the meniscus, was made. The marked degeneration and necrosis within the tumor were due undoubtedly to the temporary interposition of the tumor between the joint surfaces. The pedicle was relatively avascular. The blood vessels in the tumor showed changes of the type previously described.

Two other meniscal tumors have been examined in the laboratory. One was a triangular, pedunculated mass, freely movable, and attached to the outer and anterior surface of the internal meniscus. This was a xanthoma undergoing necrosis, microscopically. The meniscus itself was not removed. The other specimen consisted of a meniscus to which was affixed a small, roughly oval, pedunculated body, one centimeter long and eight-tenths of a centimeter wide. Microscopically, the mass consisted of hyalinized tissue and granulation tissue, in which clusters of thin-walled, blood-filled sinuses were seen in areas. There was extensive necrosis within the tumor. A diagnosis of a pedunculated granuloma, possibly on the basis of a hemangioma, was made.

\* Pieri has described a sarcoma of the internal meniscus, which occupied the anterior end of the meniscus and was the size of a small nut. The meniscus was removed. The follow-up period was only four months and, at that time, the patient, a man, thirty-one years old, was free from symptoms. A pathological diagnosis of fusocellular sarcoma of the meniscus was made and the tumor was considered malignant.

## THE CLINICAL CORRELATION

The type of trauma which causes fracture or dislocation of the meniscus becomes less with advancing age. This is generally true but not specifically so. Sports injuries play a greater part in the earlier decades, whereas accidents of major or minor degree predominate in the later decades. Thus, in the second decade, the lesion was attributed to sports in ten and to accident in six; in the third decade, to sports in thirteen and to accident in sixteen; in the fourth decade, to sports in three and to accident in thirteen; in the fifth decade, to sports in one and to accident in six. After the fifth decade, sports injuries naturally play no part.

Since a definite history of trauma is present in about seventy-six cases, and since degeneration of the meniscus appears in practically all of the menisci examined, it might be argued that the trauma causes the degeneration. This, of course, is fallacious. These findings contradict Mandl's statement that intact menisci show no change, whereas surgically removed menisci do.

Given the process of degeneration as a finding of progressive age, we may reason thus: The degenerated meniscus need not fracture and this is true in the vast majority of people. Again, the meniscus may fracture, not from any process of degeneration, but from the usual traumata which produce fracture and dislocation of the meniscus. Finally, the degeneration of the meniscus may be the direct cause of fracture,—in other words, a *pathological fracture* of the meniscus.\*

Läwen noted that spontaneous fracture of the meniscus occurred, either crosswise or lengthwise, in association with arthritis deformans. Ishido believed that not all meniscal fractures were traumatic in origin.

The first two possibilities have already been proven, both by our work and by the work of other authors. In order to prove the validity of the third proposition, we must examine cases with histories of no or atypical trauma, and cases associated with arthritis. It is to be expected that those menisci which show pathological fracture will be greatly degenerated menisci in the later age groups, with or without other joint complications. It is also expected that the trauma, either singly or serially applied, which causes the pathological fracture, will be small. Pathological fracture of the meniscus must occur uncommonly and does not obtrude itself in our minds, since we are not accustomed to think of such a pathological fracture of the meniscus.

## CASES WITHOUT A HISTORY OF TRAUMA

Eight cases are represented in this group without trauma and these may be divided into two groups. Five cases,—one in the second decade,

\* Reference should be made to the excellent paper of Andreesen which came to our attention a short time before the proofs of this paper were read. His study was confined only to operatively removed menisci. His findings and his interpretations are in general in agreement with ours. He too enunciates the concept of pathological fracture of the meniscus, though he localizes the site of fracture only at the junction of the outer vascular and inner avascular layers, the resultant longitudinal fracture corresponding, according to him, to the bipartite meniscal tear of Steinmann.

one in the third decade, two in the fourth decade, and one in the fifth decade—noted that their illness was of long duration,—from four to ten years. The fifth case had a healed pyarthrosis of the knee twenty-eight years before admission, though the duration of meniscal symptoms was not noted in the history. The remaining three cases comprised one in the fifth decade, and two in the sixth decade; in these three the duration of symptoms was short,—from four weeks to one year.

Of the two women, the one in the second and the one in the third decade, it is noted that they were children, aged twelve and fourteen respectively, when their symptoms began. An initial trauma of an unstriking degree, such as twisting the knee in playing or climbing, might well have been forgotten. In one, the cartilage was loose; in the other, it was torn. Degenerative changes were of mild to moderate degree, with mild vessel changes. The two in the fourth decade, a man and a woman, dated their symptoms five and ten years back respectively. Again, a moderate trauma might well have been forgotten. Degeneration of the meniscus in both cases was moderate. There is nothing in these four cases which suggests pathological fracture of the meniscus.

The fifth case was more complicated, in that pyarthrosis of the knee had been present twenty-eight years before and osteo-arthritis with joint mice was now present. Degenerative changes in the meniscus were marked. This might possibly be due to a pathological loosening of the meniscus, most probably dependent on the present arthritis rather than the past pyarthrosis. The meniscus was not fractured. We are none too familiar with the effects of suppuration on the menisci, though the experimental studies of Ohta indicated destruction of the menisci depending on the type of organism introduced into the knee joint. In order of frequency, the organisms having the greatest meniscolytic effects are staphylococci, streptococci, pneumococci, and, finally, bacillus coli. If the endotoxins of these bacteria are strong, the meniscus may be completely destroyed or converted into granulation tissue; if weak, there occurs some necrosis with cell nests of regeneration. The meniscal cartilage is attacked before joint cartilage.

The other three cases showed an association with arthritis. In a man, forty-three years old, with a symptom history of one year, the meniscus was loose at its anterior end. We cannot say definitely if this meniscus was pathologically loosened, though, microscopically, degenerative changes of moderate to marked degree were present. The same holds true of a woman, fifty-seven years old, who suddenly felt a snap in the knee four weeks before admission. No trauma was noted and the joint showed slight arthritic changes. Degeneration of the meniscus was of moderate degree. The last case, a colored man of fifty-seven, with a definite arthritis and snapping of the knee for ten months, showed no locking and some pain on the inner aspect of the knee joint. Broadening and fraying of the posterior part of the meniscus, with irregular transverse fracture revealed by both arthroscopy and arthrotomy, confirmed our

idea that this was a pathological fracture of the meniscus. Moderate to marked vascular and degenerative changes of the meniscus were present.

#### CASES WITH ASSOCIATED ARTHRITIS

Whether a primary arthritis creates secondary degenerative changes in the meniscus or whether degenerative changes in the meniscus may lead to arthritis is uncertain. Many English surgeons believe that an injured meniscus may provoke an arthritis, according to Hoffmann. The effects of meniscectomy on subsequent arthritis will not be discussed here.

Twelve cases of arthritis, preceding or coexisting with the meniscal lesion, are recorded in this series. Five occurred in the fifth decade, of which two have been detailed, four in the third decade, of which one has been detailed, and three in the sixth decade. None of the four cases in the third decade can be considered as showing pathological fracture of the meniscus. The arthritic process was of mild degree and located in the adjacent condyle. Two cases in the fifth decade showed probable pathological fracture of the meniscus. One case has already been detailed. The other occurred in a man in whom a synovectomy was done and in whom this old unnoticed fracture of the meniscus was seen. In a man of forty-four, in whom a synovectomy was also done, it was seen that the meniscus was thinned and frayed, though it was not fractured. In the sixth decade, two cases of pathological fracture or loosening of the meniscus were noted. One case has already been detailed. The other occurred in a woman in whom an arthritis of the knee was present for ten years. The meniscus was loose and frayed and showed marked degenerative changes.

A marked degeneration of the ground substance, with a preponderance of mucoid degeneration, was noted in those menisci considered pathologically fractured or loosened.

Joint mice were coincidentally present in one case in the third decade, in three cases in the fifth decade, and in one case in the sixth decade, in association with arthritis. Two cases in this series showed Pellegrini-Stieda's disease,—that is, a paracondylar ossification—and in one, the bony mass was removed. Tears and fraying of the crucial ligaments, injury to the infrapatellar fat pads, hypertrophic synovitis, tearing of the ligamentum mucosum, adhesions, etc., may accompany meniscal disease.

#### CONCLUSIONS

Degeneration of the menisci of the knee joint occurs as a typical change of progressive age. The severity of degeneration does not always parallel age. This degeneration is noted equally in both menisci, and in menisci which have been surgically removed, as well as in menisci which have remained intact in the knee. The term "meniscosis" is suggested to describe the degenerative changes which the meniscus undergoes. The exact relation between degeneration of the meniscus and the alteration of the blood vessels described is quantitatively uncertain. The menisci tend

to regress under several factors which include daily small traumata of subclinical import, poor vascularity quite independent of vessel pathology, the presence of intra-articular disease, vessel alterations which are so frequently present, and probable alterations in synovial nutrition. Hempel has indicated that cartilage may be destroyed by ferments in the synovial fluid. If this is true, this may hold true too for the menisci, which receive some nutrition from the synovial fluid.

Meniscitis does not exist as an entity. Meniscosis need not express itself clinically; though rarely, in the later decades of life, it may be the cause of pathological fracture of the meniscus, in a patient without a history of trauma or in association with arthritis. Meniscal cysts are degenerative in origin.

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## EXTRA-ARTICULAR ARTHRODESIS OF THE SHOULDER \*

BY R. WATSON JONES, B.SC., M.CH.ORTH., F.R.C.S. (ENG.), LIVERPOOL,  
ENGLAND

Tuberculosis of the shoulder joint is characterized by the particularly chronic course of the disease, and by the tendency to slowly progressive destruction of the head of the humerus and of the glenoid. So extensive is the bone destruction that the upper end of the humerus gradually sinks inward, leaving a very marked hollow below the prominent acromion process, which accounts for the "pseudo-dislocation" described by older writers. Despite the extensive bone destruction there is relatively little caseation, and the rarity of abscess or sinus formation has led to the nomenclature of "caries sicca". Since sinuses are uncommon, there is seldom secondary pyogenic infection, and bony ankylosis is rarely secured.

In the past, it has been accepted that the duration of the disease in the shoulder joint is from three to five years. It is well recognized that the functional result is only satisfactory if the humerus is ankylosed to the scapula at an angle of seventy or eighty degrees' abduction, thirty degrees' external rotation, and thirty degrees' forward flexion. The limb must be held in this position not only until the disease is quiescent but until the fibrous ankylosis is sufficiently firm to maintain the position. There can be little doubt that it is the second factor which has been of greater importance in determining the unusually prolonged recovery period. Quiescence should be secured by immobilization and general treatment just as quickly in the shoulder as in the elbow, knee, or any other joint. But, if the limb is released from the abducted position when the disease is quiescent in twelve or eighteen months, the fibrous union will gradually stretch, owing to the weight of the limb, the effect of gravity, and the position of rest of the limb by the side of the trunk. Gradually the angle between the humerus and the scapula is reduced, the range of abduction secured by scapular movement becomes less, and ultimately ankylosis is consolidated in a position which is no better than it would have been had the limb never been abducted. For these reasons, patients have had to resign themselves to the discomfort and inconvenience of an abduction frame or plaster spica for no less a period than three, four, or five years, because only after that interval is the ankylosis sufficiently consolidated to retain adequate shoulder movement.

Extra-articular arthrodesis has been practised in the spine for many years, and more recently has been advocated by Hibbs in the hip joint. Although Hibbs himself believed that extra-articular arthrodesis was a measure of value in the treatment of tuberculous disease at all stages, this broad view has not been generally accepted. In England the usual practice still is to adopt conservative measures until the disease is quiescent;

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but more and more widely it is being recognized that an extra-articular arthrodesis is often advisable in the terminal stages of treatment, in order to consolidate ankylosis and to prevent recurring deformity. This is the routine which is now very generally adopted in the treatment of tuberculous disease of the hip.

How much more definite is the indication for extra-articular arthrodesis of the shoulder joint as a terminal phase of treatment? The tendency to deformity is much more marked in the shoulder than in the hip because the constant action of gravity must be contended with. Moreover, it is always possible to fit a plaster or leather spica to the hip joint, which will control deformity without preventing the patient from resuming his occupation. In the shoulder, on the other hand, deformity can only be controlled by continuing the complete treatment of fixation in abduction, a measure which absolutely prohibits the resumption of active work.

Not only is the indication for operation particularly strong, but the anatomical features of a shoulder which has been disorganized by tuberculous disease are peculiarly favorable to extra-articular arthrodesis. Intra-articular arthrodesis is notably unreliable even in the healthy shoulder joint, and it is still more difficult to secure bony union by Steindler's intra-articular arthrodesis of the tuberculous shoulder. But, where the glenoid and the greater part of the humeral head have been destroyed, the inward displacement of the upper end of the humerus leaves the acromion process projecting well beyond it. It is now a perfectly easy procedure to angulate the acromion downward, and implant it in the upper shaft of the humerus in the region of the greater tuberosity. In this way, firm bony ankylosis is secured between the humerus and the scapula without actually encroaching on the diseased area. The cosmetic appearance is very materially improved, because there is no longer a hollow where the head of the humerus should be, with the very ugly projecting spur of the acromion process above it. The normal rotund outline of the shoulder is restored.

#### TECHNIQUE OF NEW OPERATION

A straight incision is made over the point of the shoulder, centering on the tip of the acromion process (Fig. 1). It extends upward for about three inches midway between the clavicle and the spine of the scapula, and extends downward for a similar distance toward the deltoid insertion. The flaps are dissected up sufficiently to expose the whole of the outer surface of the upper three inches of the humerus, the outer third of the clavicle, the acromioclavicular joint, and the outer third of the spine of the scapula (Fig. 2-A).

The deltoid is separated subperiosteally from the clavicle, acromion, and scapula, and the fibromuscular flap is turned downward. Both upper and lower surfaces of the acromion process are freshened and made raw by removing the cortical layer of bone.

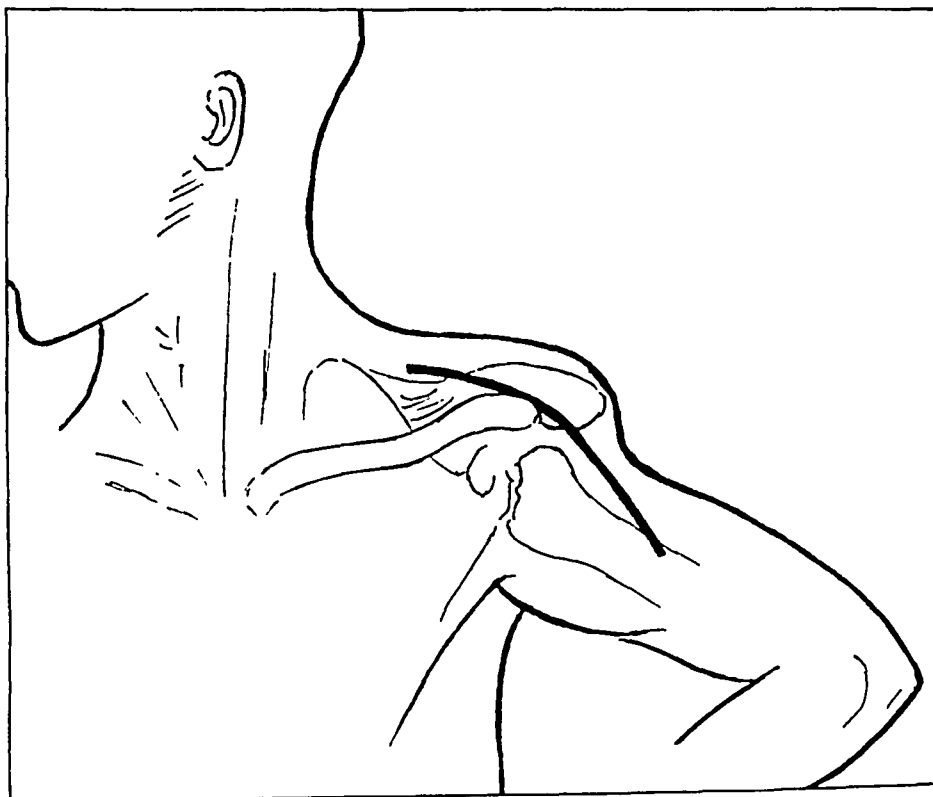


FIG. 1

Line of incision.

A broad flap of bone, one inch wide and two inches long, is raised from the outer surface of the upper end of the humerus by driving an osteotome vertically into the upper part of the greater tuberosity immediately beyond the capsular attachment, the osteotome being held in the long axis of the humerus (Fig. 2-B). The flap of bone is gently levered outward, but is not completely fractured at its base, so that when the osteotome is removed the flap tends to spring back into position.

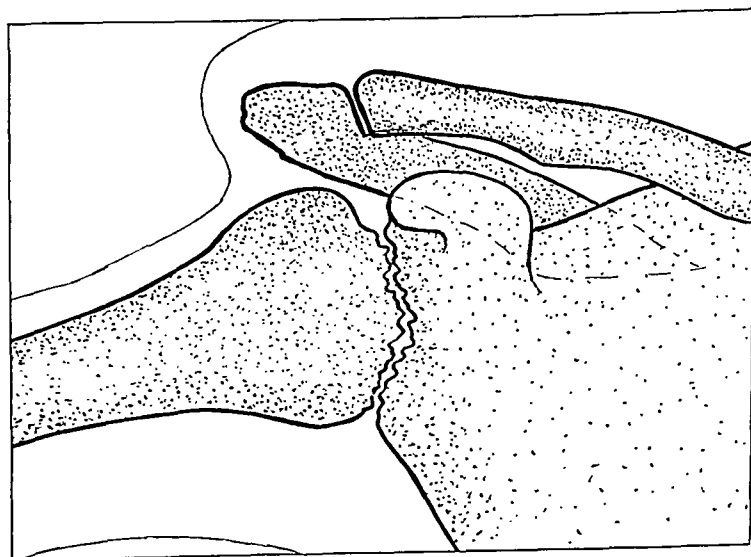


FIG. 2-A

The clavicle is partly fractured a few inches from its outer end, and the spine of the scapula is partly fractured at a similar level. The arm must now be held in the abducted position, and the whole acromioclavicular mass is angulated downward, hinging at

the point where the bones were half fractured. It is wedged underneath the flap of bone raised from the humerus, so that its raw, freshened surfaces are impacted into the cancellous bone of the upper shaft of the humerus (Fig. 2-C).

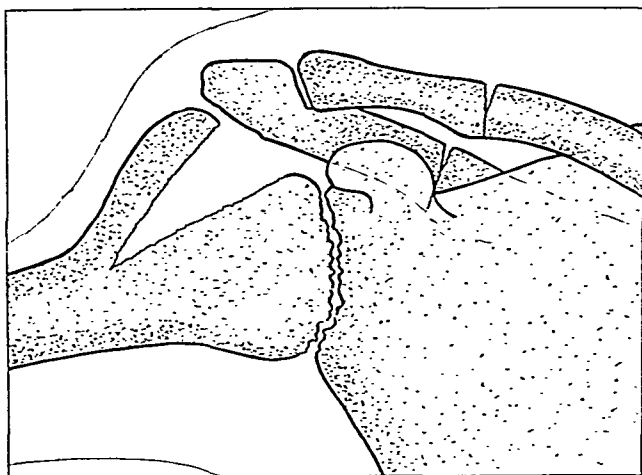


FIG. 2-B

#### Fixation

may be augmented by a few strong sutures, and if necessary bone chips or osteoperiosteal grafts from the tibia may be implanted. The wound is closed in layers and the limb put up in a plaster spica, in a position of eighty degrees' abduction, thirty degrees' forward flexion, and thirty degrees' external rotation.

#### POSTOPERATIVE TREATMENT

In a fortnight, when the stitches have been removed, the wound is healed, and the postoperative swelling has subsided, a very closely fitting plaster spica is applied over a single layer of thin stockinet. The position is confirmed roentgenographically, and, if it is satisfactory, the plaster remains undisturbed for four months. If further roentgenograms show bony fusion, the plaster is removed and an abduction frame applied. The patient practises abduction movements and, when the scapular muscles are sufficiently developed to enable him to hold the limb against gravity in right-angled abduction, the frame is gradually discarded. At first it is left off for an hour a day, but the period of freedom is rapidly increased so long as the power of active abduction is retained.

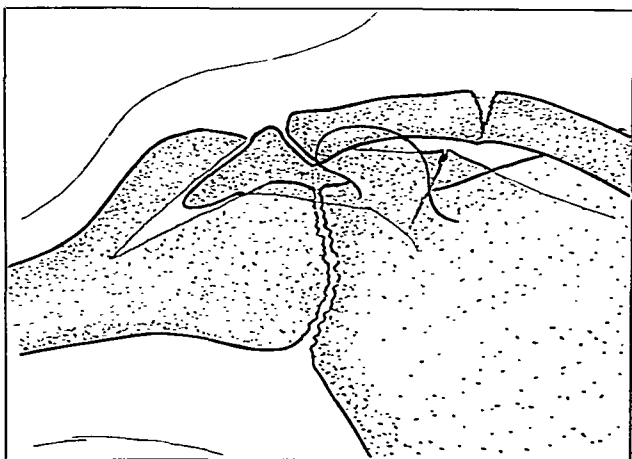


FIG. 2-C

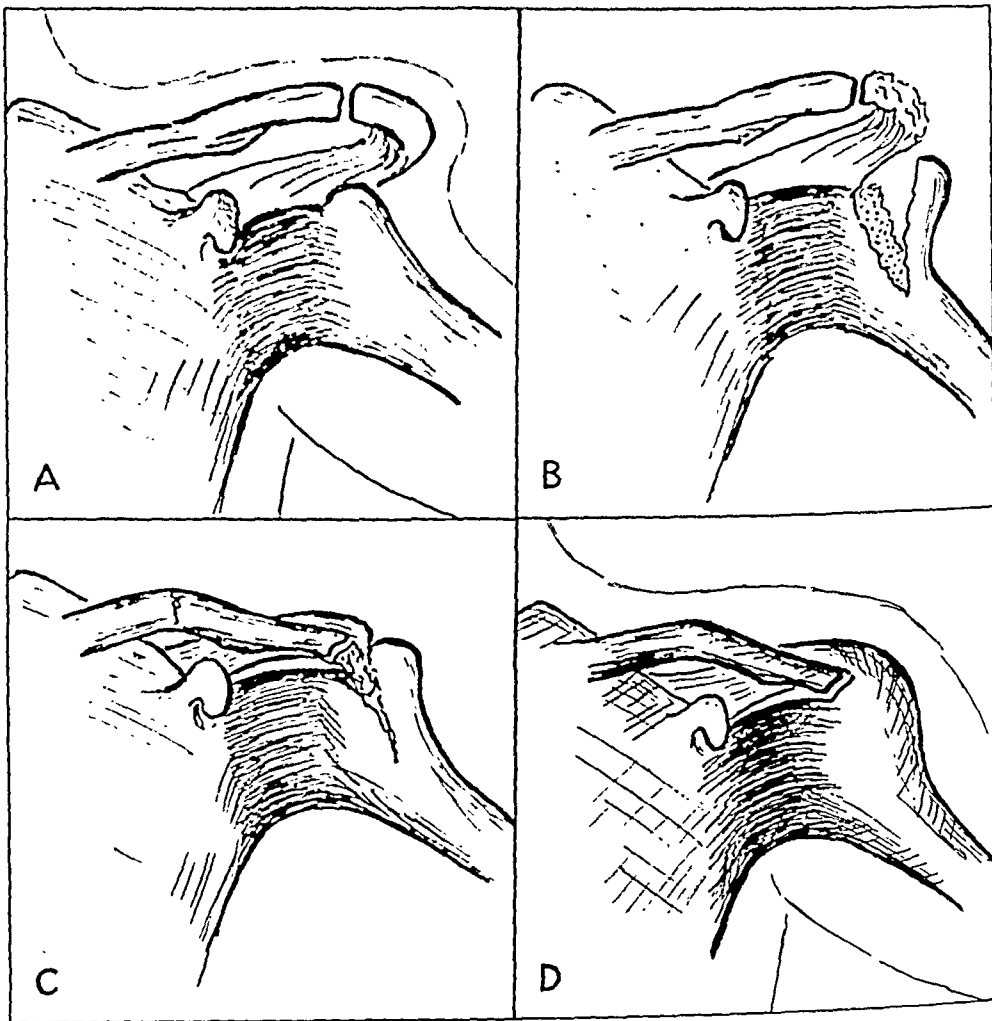


FIG. 3

Stages of the arthrodesis, showing the relation of the graft to the capsule.

A. Before operation. Owing to bone destruction, the head of the humerus has sunk inward leaving the acromion abnormally prominent.

B. The acromion has been freshened and the flap of bone raised from the humerus.

C. The clavicle and spine of the scapula have been fractured and the acromion is impacted into the cancellous bone of the upper end of the humerus.

D. The end result after extra-articular fusion.

The operation has been performed in three cases of tuberculosis of the shoulder, and in each case a sufficient interval of time has elapsed to judge the result.

#### CASE REPORTS

CASE 1. P. B., male, aged seventeen years:

*July 1929.* Seven months' history of weakness of shoulder. Progressive difficulty in abduction. Clinically and roentgenographically typical of caries sicca. Conservative treatment by frame immobilization for eighteen months. Roentgenograms then showed recalcification of glenoid and head of humerus (recalcification = diminution of hyperaemia = quiescence). Extensive destruction but no ankylosis (Fig. 4-A).

*January 1931.* Extra-articular arthrodesis. Wound healed by first intention. Plaster spica for four months. Frame gradually discarded during next month.

*June 1931.* Roentgenogram showed firm bony ankylosis (Fig. 4-B).

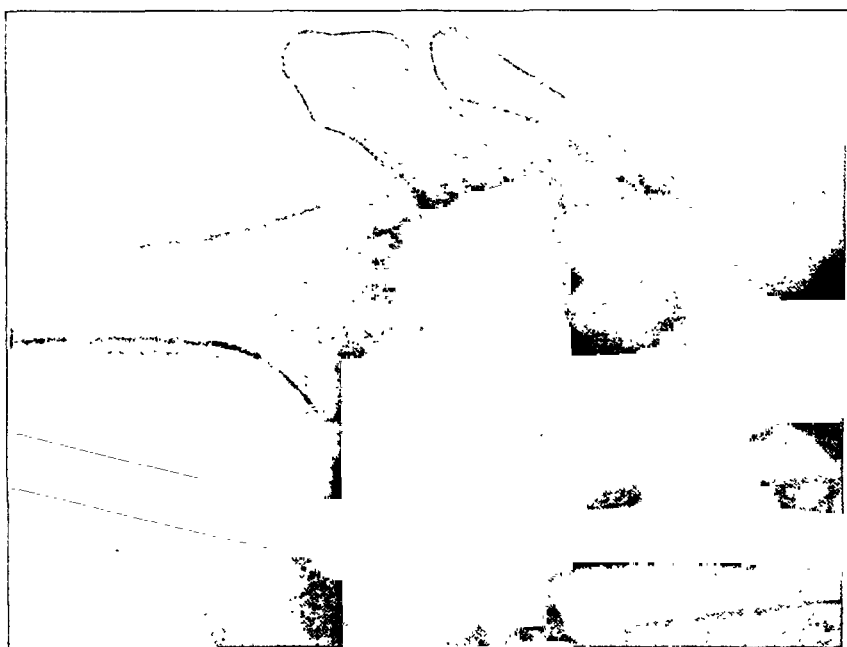


FIG. 4-A

Case 1. Roentgenogram of shoulder after eighteen months' frame immobilization.

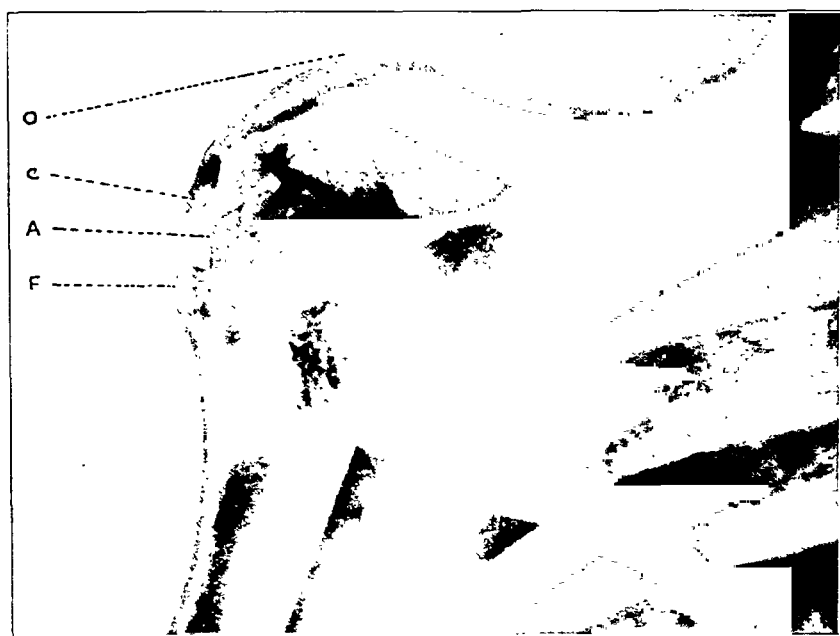


FIG. 4-B

Case 1. After extra-articular arthrodesis. C=clavicle, articulating with A, the acromion, which is firmly fused with the humerus. F=outer margin of the flap of bone raised from the humerus. O=level of osteotomy of clavicle.





FIG. 5-A

Case 2. Roentgenogram of shoulder at commencement of treatment.

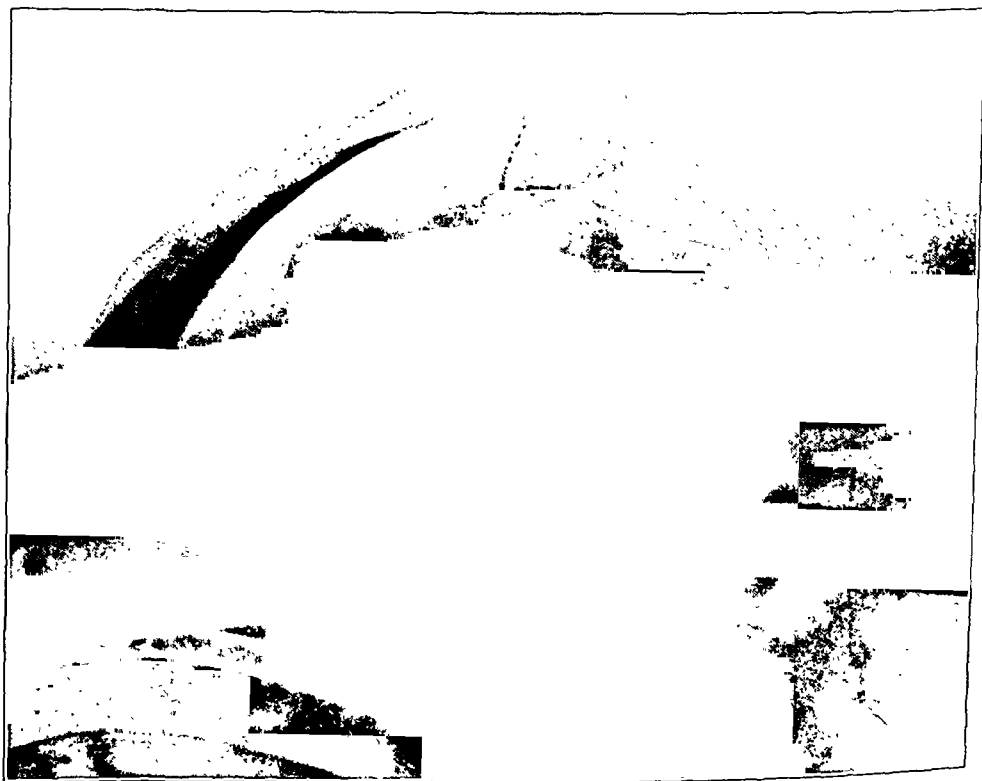


FIG. 5-B

Case 2. Roentgenogram after six months' conservative treatment by frame immobilization.

*November 1932.* No recurrence of symptoms, and no recurrence of disease elsewhere. Can abduct limb through 110 degrees and can reach face and head easily. Cosmetic result fairly good.



FIG. 5-C

Case 2. Six months after extra-articular arthrodesis.



FIG. 5-D

Case 2. Photograph showing end result.

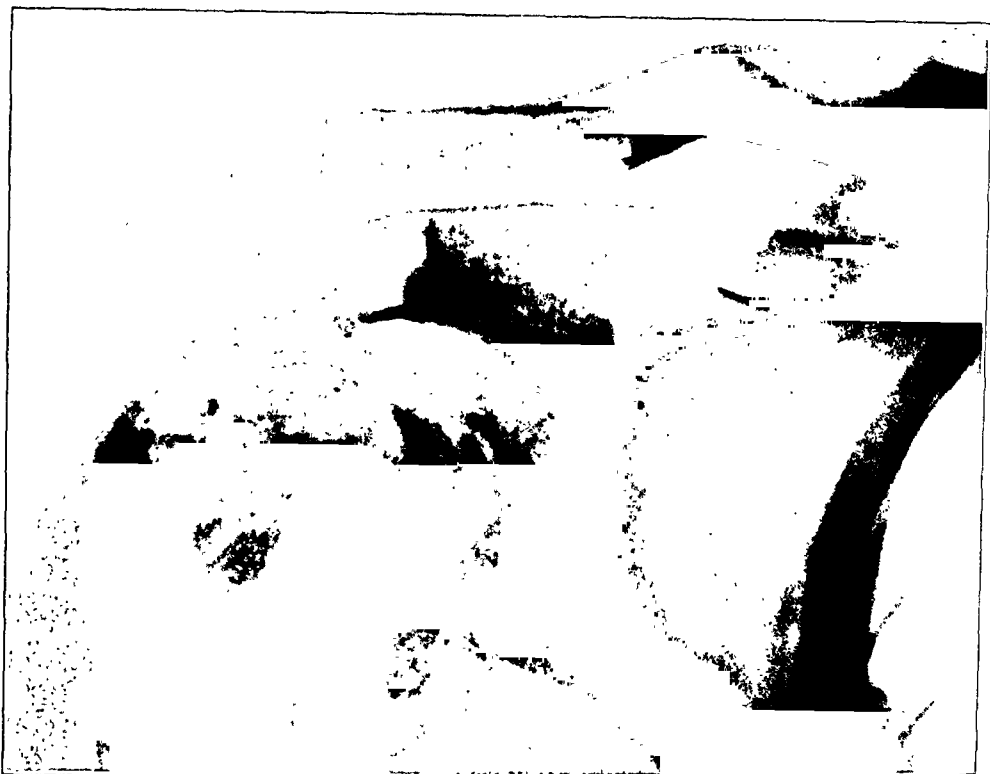


FIG. 6-A

Case 3. Roentgenogram at commencement of treatment (tuberculosis confirmed microscopically).



FIG. 6-B

Case 3. Roentgenogram six months after excision of joint and combined intra-articular and extra-articular arthrodesis. (In this case the clavicle, as well as the acromion, has been freshened and impacted into the humerus.)

CASE 2. R. S., male, aged twenty-one years:

*October 1930.* Six months' history of pain and stiffness in right shoulder. Roentgenogram confirms clinical diagnosis of caries sicca (Fig. 5-A). Conservative treatment by immobilization in abduction frame for six months. Roentgenogram shows recalcification (Fig. 5-B).

*April 1931.* Extra-articular arthrodesis with reenforcement by osteoperiosteal grafts. Stitch abscess drained for few weeks. Plaster spica four months. Frame gradually discarded during next four months.

*December 1931.* Roentgenogram shows firm consolidation (Fig. 5-C).

*July 1932.* Excellent result. Cosmetic result very satisfactory (Fig. 5-D). Movements of shoulder girdle fifty per cent. of normal. Firm bony ankylosis. Disease cured. No recurrence of symptoms.

CASE 3. W. R., male, aged thirty-eight years:

*January 1932.* Three weeks' history of pain in the shoulder. Roentgenograms show extensive destruction of the head of the humerus. Tuberculous disease has been present in bone much longer than three weeks. More recent involvement of joint (Fig. 6-A). Conservative treatment in frame for three months. No further destruction.

*April 1932.* Combined intra-articular and extra-articular arthrodesis. Caseous masses evacuated from head of humerus. Owing to involvement of greater tuberosity, extra-articular fixation was more difficult than usual. The clavicle, as well as the acromion, was freshened and impacted into the humerus. Plaster spica applied for four months. Delayed healing of wound.

*November 1932.* Still wearing frame for part of day. Clinically, ankylosis is firm and painless. Roentgenographically, humerus and spine of scapula firmly united (Fig. 6-B). Joint becoming obliterated. No recurrence of symptoms. Movements of shoulder girdle forty per cent. of normal.

#### SUMMARY

Tuberculous disease of the shoulder joint recovers slowly by fibrous ankylosis which becomes sufficiently firm to maintain the abducted position only after several years' fixation. The disease occurs most commonly in the adult, and the average duration of conservative treatment is three to five years. Attempted acceleration of treatment reduces the scapulo-humeral angle and abduction movement is lost.

For these reasons operative fusion of the joint is indicated as a terminal stage of treatment after quiescence has been secured by conservative measures. Roentgenographic evidence of quiescence, shown by recalcification of the bones, appears within about twelve months.

A new operation is described by which solid bony fusion can be secured without opening the joint, and the arthrodesis is definitely extra-articular. The cosmetic result is considerably improved by the operation.

Three cases are reported in which a sufficient interval of time has elapsed to judge the operation. In no case was there any aggravation of the disease or recurrence elsewhere, and in all three cases bony ankylosis resulted.

# PRESPONDYLOLISTHESIS

## ITS ROENTGENOGRAPHIC APPEARANCE AND CLINICAL SIGNIFICANCE \*

BY SAMUEL KLEINBERG, M.D., NEW YORK, N. Y.

*From the Hospital for Joint Diseases*

The orthopaedic surgeon is at present concerning himself with an intensive investigation of the causes of back disability. Certain congenital lesions of the spine are known to be important etiological factors in static and traumatic disturbances of the lumbosacral area. To this group may now be added prespondylolisthesis, a condition in which there is a congenital laminar defect of the last lumbar vertebra without displacement of any of its segments.

Somewhat over two years ago, the author operated on the lumbosacral area of a young man's spine to obtain a vertebral fusion in a very painful back, the roentgenogram of which appeared normal. He found the posterior arch of the last lumbar vertebra abnormally movable as a result of a bilateral defect in the neural ring at the pedicles. This stimulated him to a more critical study of the roentgenograms of cases of back disability. He soon discovered two patients with backache in whose roentgenograms he demonstrated a defect in the pedicles of the last lumbar vertebra, and confirmed this in the case of one of them who submitted to operation. The two patients who were operated upon were relieved of their backache and disability. The laminar defect noted in these three cases was similar in location and appearance to that seen in cases of actual dislocation of a lumbar vertebra, or spondylolisthesis. It seemed reasonable to assume that in these patients the author was dealing with a situation which in its essential pathology was a precursor to a slipping of the vertebral body, and hence appropriately called a prespondylolisthesis. He has since found six additional cases, in three of which he has had the opportunity of operating and actually seeing the area in which there was an osseous defect.

The clinical history of prespondylolisthesis has been very much the same in all of the cases. The patients, who thus far have all been adults, complain of a sense of weakness and pain in the lower part of the back. The pain may come on suddenly, as after some strain, or gradually in the course of more or less arduous work. Once the pain appears, it continues, with some remissions. It is aggravated by strenuous physical activity and is relieved by rest and support of the back. The pain is most pronounced at the lumbosacral area. In several of the patients there was an accompanying right sciatic neuralgia. In two cases there was increasing weakness in the lower limbs which interfered with locomotion.

\* Read before the American Orthopaedic Association at Washington, D. C., May 9, 1933.

The physical examination yields little that is definitive. Usually there is local tenderness to pressure at the lumbosacral junction. If the backache is marked there may be spasm of the erector spinae muscles with some limitation of the spinal motions. There may or may not be an exaggeration of the lumbar lordosis. There are no gross neurologic changes. The subjective symptoms and the objective findings indicate a lesion in the lower lumbar region, and the need for a roentgenographic study.

The roentgenograms reveal the pathology. In the anteroposterior view the vertebrae appear normal.\* In the lateral view, however, one sees a vertical or slightly oblique defect in the pedicles between the articular processes of the last lumbar vertebra, separating the body and superior articular process in front from the inferior articular process and the neural arch posteriorly, exactly as one finds it in a spondylolisthesis. The alignment of the lumbar vertebrae and the sacrum is entirely undisturbed. The osseous defect varies in width from approximately a sixteenth of an inch to an eighth of an inch. The outlines of the adjacent bony surfaces are irregular. There is no sign of any new bone deposit. The defect is sometimes seen more clearly in an oblique view. In a little over half the cases there is an exaggeration of the lumbosacral angle, with the sacrum sometimes almost horizontal and the lumbosacral plane nearly vertical.

The findings at operation are dramatically convincing. As soon as one cuts through the lumbar fascia it becomes at once apparent that the posterior arch of the affected vertebra (in all of the cases here reported it has been the last lumbar vertebra) is abnormally movable and loose. If one grasps the spinous process of the third or fourth lumbar vertebra with a strong clamp, one can obtain some slight movement of the vertebra. When one takes a similar hold of the spinous process of the last lumbar vertebra, he can move it and the laminae vertically and laterally a distance of perhaps half an inch, obtaining an uncomfortable sense of looseness in the attachment of these structures. When the laminae and pedicles are exposed by subperiosteal dissection, a defect is found in the pedicles. In none of the author's cases was there any callus to suggest a fracture. This is entirely in accord with Willis's findings in his studies of cadavera with spondylolisthesis.

A study of five hundred roentgenograms of the lumbosacral area discloses two instances of prespondylolisthesis and two of spondylolisthesis. This average is much below Willis's figures for congenital osseous defects in the neural arch of the lower lumbar vertebrae. But the films examined were made five or six years ago when the technique of roentgenography was not quite so accurate as at present. The author believes that a more recent group would give a greater incidence of vertebral

\* One of the author's cases is perhaps an exception to this. In this instance there was visible a horizontal linear defect in the neural arch below each articulation between the fourth and fifth lumbar vertebrae. This may be merely a chance finding.

laminar defects. What is more important, however, is the fact that the histories of the cases of prespondylolisthesis showed that all but one of the patients had symptoms referable to the back. The patient who was the one exception had pains along both lower limbs, which led a somewhat inexperienced examiner to be surprised because the individual did not have enough of a flat foot to account for the pain, overlooking the fact that pains in the lower limbs may be an expression of a spinal lesion.

The author has collected nine cases of prespondylolisthesis. The details of their histories, the findings in the physical examination, in the roentgenograms, and at operation are recorded in the case reports which follow. All the patients were adults, most of them past middle age. Presumably the condition continues asymptomatic until some circumstance—a single marked injury or a succession of minor strains—stretches and loosens the connective tissue bridging the defect, following which backache and disability ensue. It may be assumed, too, that in some patients the osseous lesion is unilateral so that symptoms of strain never appear, or else are so mild as to be overlooked. There must be many instances without symptoms which do not reach the surgeon.

The recognition of the existence of a state of prespondylolisthesis has a twofold importance. First, prespondylolisthesis itself is a competent cause of backache and back disability, and it can, by appropriate treatment, be satisfactorily controlled. Secondly, prespondylolisthesis manifestly precedes actual subluxation of a vertebral body, or spondylolisthesis, as no case of spondylolisthesis has been discovered in the newly born. Consequently, it seems reasonable to conclude that, if a laminar defect is detected, the occurrence of a spondylolisthesis can be prevented by a spine fusion.

### CASE REPORTS

CASE 1.\* J. W., aged thirty-three years, fell two and a half years ago, striking his back against a post. Since then he has had disabling backache. The examination, clinical and roentgenographic, was negative. At operation, which was performed because conservative treatment had not given any relief, the author found a separate neural arch due to a bilateral defect at the pedicles. The operation, a spine fusion, resulted in a cure.

CASE 2.\* O. L., aged forty-one years, a carpenter, consulted the author at his clinic about one year ago for increasing and disabling backache. The patient was well up to four months previously when, without any apparent cause, he experienced pain in the lower part of his back. This pain became gradually worse, so that walking was very difficult. The examination revealed an increase in the lumbar hollow, inconstant tenderness at the lumbosacral junction and slight limitation of the spinal motions. The lateral roentgenogram showed an almost horizontal sacrum and a laminar defect, almost an eighth of an inch wide, in the fifth lumbar vertebra. The alignment of the lumbar vertebrae and the sacrum was normal. A spine fusion was performed. At operation there were found a loose posterior arch and a bilateral laminar defect in the fifth lumbar vertebra. This man has been completely relieved.

\* These three cases were included in a communication on "Spondylolisthesis and Prespondylolisthesis" sent some time ago to *Archives of Surgery* and shortly to be published therein.

CASE 3.\* H. G., aged sixty-four years, came to the author's clinic because of pain of four weeks' duration in the back and the right thigh. The physical examination was negative, but the lateral roentgenogram showed a wide laminar defect.

CASE 4. N. P., aged forty-one years, fell while at work, striking his back. He had immediate backache, which increased until he could not get about. He was seen several months after his injury, at which time he complained of pain in his back and the back of the right lower limb, approximately in the course of the sciatic nerve. The pain was increased by all movements of his body, so that he was practically totally incapacitated. The patient was a particularly well built man who had difficulty in walking and even in standing. His body was tilted to the left. His lumbar spine was flat. There was marked tenderness at the lumbosacral junction and limitation of the spinal

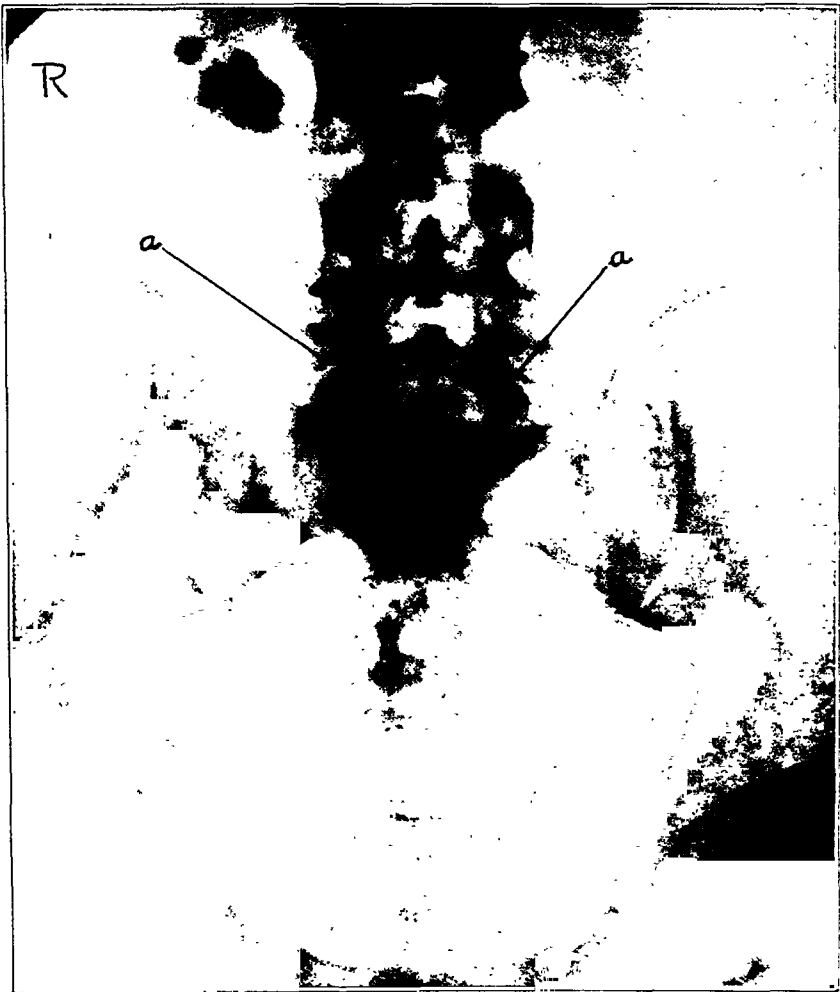


FIG. 1

Case 4. Anteroposterior view, showing horizontal defect below each superior articular process.

\* See foot-note, page 874.



motions. There were no neurological changes. The anteroposterior roentgenogram (Fig. 1) showed a peculiar, almost horizontal defect through each lamina directly below the superior articular process. The lateral view showed vaguely a laminar defect.

A diagnosis of prespondylolisthesis was made and a spine fusion advised. It was felt that the lesion was undoubtedly congenital, but the injury had stretched the connective tissue at the laminar defect, resulting in abnormal laxity of the posterior arch of the fifth lumbar vertebra and causing disabling backache. At operation, the author found that the posterior arch of the fifth lumbar vertebra was very freely movable by reason of a bilateral defect in the pedicles between the articular processes. Apparently movement of the posterior arch during the operation increased the gap of the laminar defect, because a subsequent lateral roentgenogram (Fig. 2) shows the osseous lesion more clearly than the original picture. This patient is still under observation at the hospital.

CASE 5. N. D., aged fifty-five years, was admitted to the author's service for pain in his back, especially the coccyx. He was well until two years ago, when without any known cause, he experienced severe pain in the upper part of his back, radiating to the sides. The backache diminished in degree, but persisted. Five months before admission he began to have severe pain in the lumbar area. Two weeks before entering the hospital his coccyx became so painful that he sought medical aid.

Examination showed a thin, worn-out looking individual who had marked round shoulders and a hollow back. His lumbar spine was freely movable. His coccyx was abnormally movable and tender. Neurological investigation was negative. The roentgenograms showed a dorsal spondylitis. Also, in the lateral view of the lumbosacral area, a defect in the posterior arch of the last lumbar vertebra was visible (Fig. 3). The alignment of the lumbar vertebrae and the sacrum was normal. There was a slight increase in the lumbosacral angle. The laminar defect is very clearly seen in the original film, but not in the copy here reproduced.

A spine-fusion operation was performed. The posterior arch was found to be loose and abnormally movable, exhibiting a bilateral laminar defect through the pedicles between the articular processes.

CASE 6. F. McD., aged twenty-nine years, injured her spine in an automobile accident in October 1930. A diagnosis of fracture of the spine was made and a plaster-of-Paris jacket was applied. This was discarded in about six months as she felt well except for occasional pain in the back, radiating down the right lower limb. For several years this patient has had unexplained periodic attacks of vomiting and pain in the right upper quadrant of the abdomen. The patient was admitted to the medical service of the hospital in December 1932. Very thorough examination, including a gastro-intestinal roentgenographic series, revealed no abdominal lesion, and she was transferred to the author's service.

Examination on January 21, 1933, showed a somewhat overweight person with a marked round, hollow back. The spinal motions were unrestricted. There was tenderness along the lumbar spine, especially at the lumbosacral junction. There were no neurological disturbances. The roentgenogram showed in the lateral view (Fig. 4) an ancient healed compression fracture of the body of the twelfth dorsal vertebra, and a marked laminar defect in the fifth lumbar vertebra with normal alignment of the lumbar vertebrae and the sacrum,—that is, a prespondylolisthesis.

A spine fusion for stabilization of the lumbosacral area was advised and performed. The operation revealed a markedly loose posterior arch of the fifth lumbar vertebra with a bilateral laminar defect, as shown in the accompanying drawing (Fig. 5) made for the author by his resident, Dr. Lieberman. The extreme laxity of the posterior neural arch in this and the other cases justified Dr. Willis's term of "separate neural arch".

CASE 7. Mrs. J. S., aged forty-three years, consulted the author for pain in the lower back. This radiated down the back of the right thigh and leg to the dorsum of

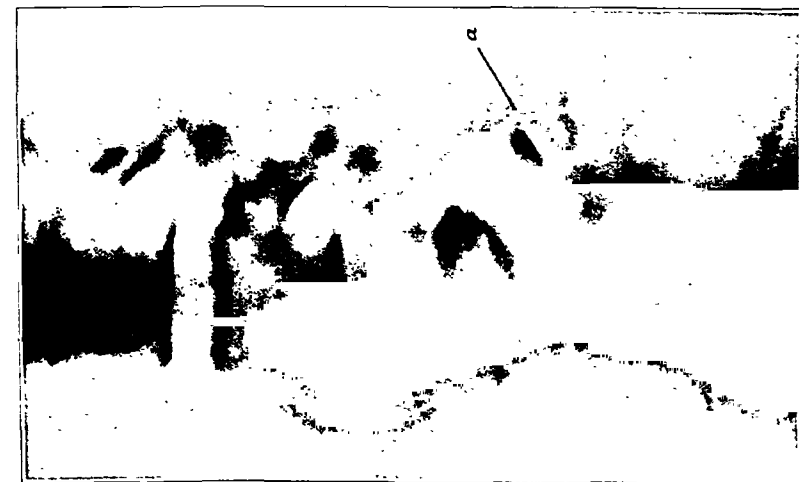


FIG. 2

Case 4. Lateral view. Note wide laminar defect at *a*. In this instance the graft was extended from the second lumbar vertebra to the middle of the sacrum to assure thorough immobilization.

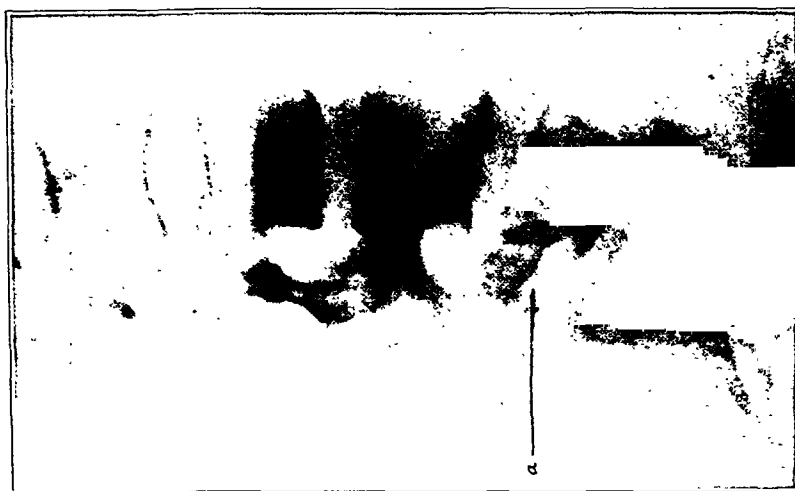


FIG. 3

Case 5. Lateral view; *a* points to laminar defect in fifth lumbar vertebra.

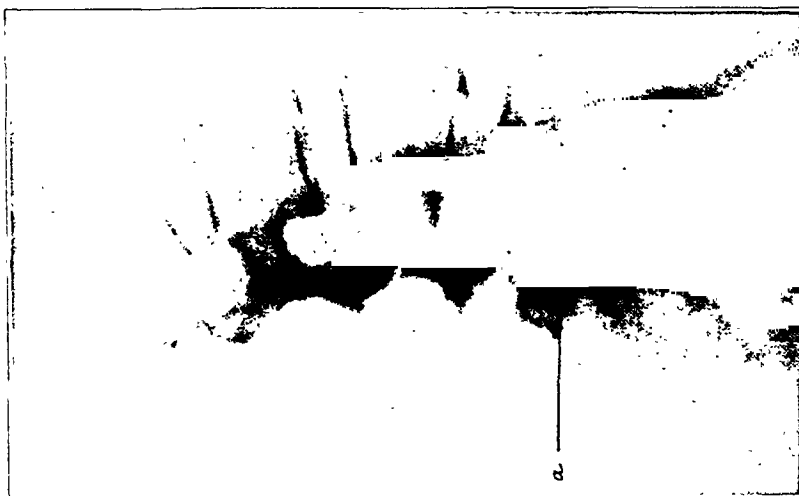


FIG. 4

Case 6. Lateral view, showing wide defect or gap in neural arch of fifth lumbar vertebra. This was confirmed at operation.

her foot. The backache, which began about six months previously without any apparent cause, is more or less continuous; it is aggravated by exercise and relieved by rest.

The patient is short, stocky, and overweight. Her back is symmetrical but with some increase in the lumbar hollow. There is definite restriction of all movements of the lower lumbar spine, with tenderness to pressure in this region. Pressure over the lumbosacral area causes pain along the right sciatic nerve. The roentgenograms show a laminar defect of the fifth lumbar vertebra, establishing the diagnosis of prespondylolisthesis.

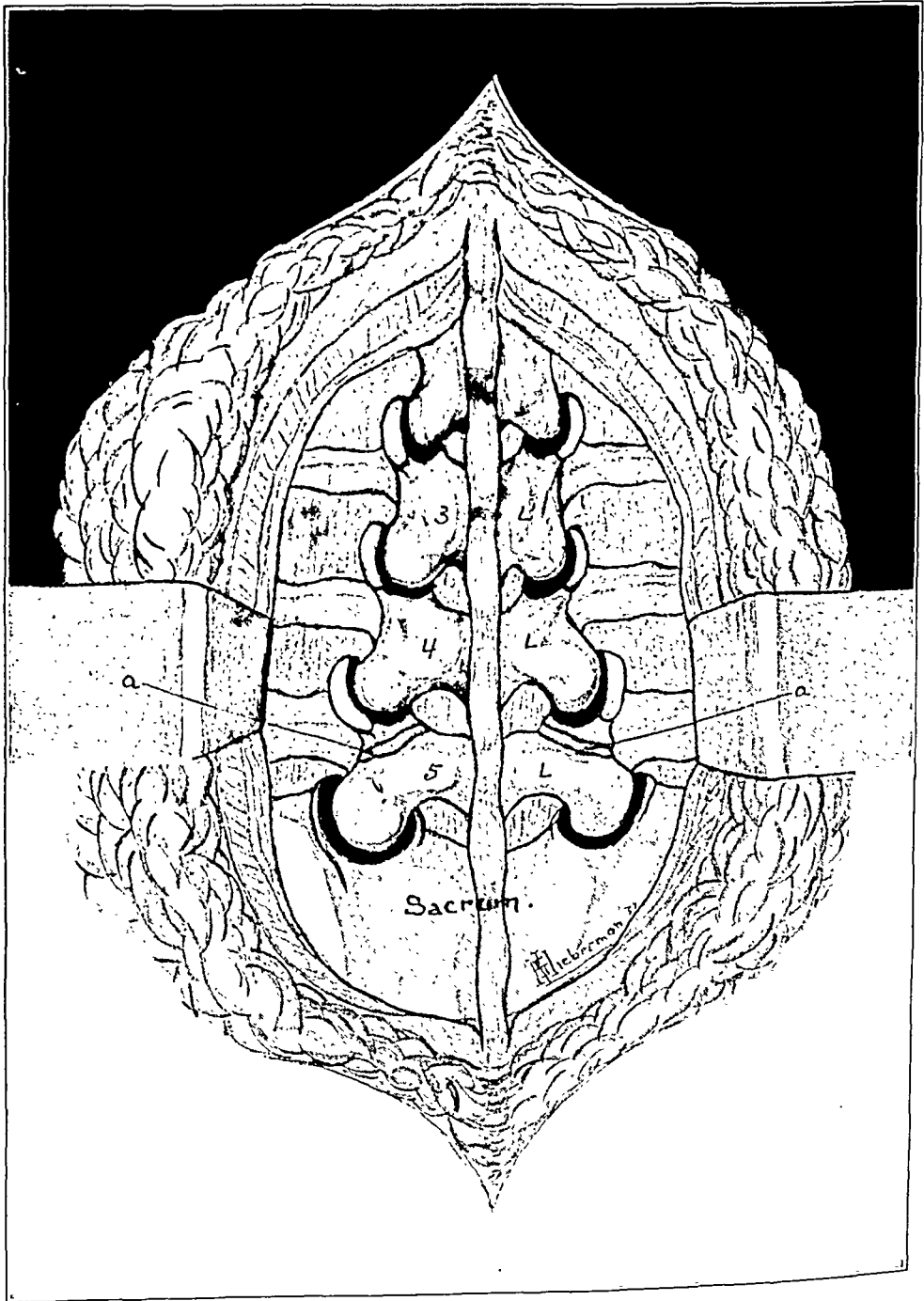


FIG. 5

Case 6. Diagrammatic sketch of operative findings: *a* indicates defect on both sides of neural arch of fifth lumbar vertebra; the broad black lines indicate intervertebral articulations.

CASE 8. J. P., aged thirty-three years, came to the out-patient department in May 1927, complaining of pain in the lower back and in both legs. The pain had persisted for five years, but finally had become so severe that the patient had difficulty in walking. There was marked stiffness of the lumbar spine and tenderness at the lumbosacral junction. The clinical diagnosis was lumbar arthritis with secondary sciatica. The roentgenographic evidence was not appreciated at that time. The lateral view (Fig. 6) shows clearly a large, ragged defect, nearly a quarter of an inch wide, in the pedicles of the fifth lumbar vertebra. In this case the posterior arch of the fifth lumbar vertebra was so loose that it manifestly could cause the train of severe symptoms of which the patient complained.



FIG. 6

Case 8. Lateral view. Note unusually wide and ragged defect in pedicles of fifth lumbar vertebra.

CASE 9. T. T., aged thirty-four years, came to the dispensary in May 1927. For ten months he had complained of pain in the back. He gave no history of injury, and the clinical examination was negative. The present examination of the lateral roentgenogram shows a wide laminar defect in the fifth lumbar vertebra. Unfortunately, the film had a finger streak across the sacrum, obscuring its outline. As the significance of the osseous defect was not appreciated at the time this patient was under observation, no effective treatment was instituted.

A résumé of the findings in the nine cases is given in the following tables:

TABLE I

## REVIEW OF CASES OF PRESONDYLOLISTHESIS

Total number.....	9
Males.....	7
Females.....	2
Ages 20 to 30.....	1
30 to 40.....	3
40 to 50.....	3
50 to 60.....	1
60 to 70.....	1
History of injury.....	3
No injury.....	6

TABLE II  
RÉSUMÉ OF NINE CASES OF PRESPONDYLOLISTHESIS

Case No.	Name	Sex	Age	History of Injury	Duration of Symptoms	Subjective Symptoms	Objective Symptoms	Neurologic Symptoms	Roentgenographic findings	Operated
1.	J. W.	M	33	Yes	2½ years	Backache.	Negative.	—	—	Yes
2.	O. L.	M	41	No	4 months	Backache. Difficult walking.	Lordosis. Tenderness at lumbosacral junction. Limitation of spinal motions.	—	+	Yes
3.	H. G.	M	64	No	4 weeks	Backache and right sciatica.	Negative.	—	+	No
4.	N. P.	M	41	Yes	6 months	Backache and right sciatica.	Difficulty in walking. Tenderness at lumbosacral junction. Limitation of lumbar movements. Flat back.	—	+	Yes
5.	N. D.	M	55	No	5 months	Backache.	Hollow back. Spinal motions free.	—	+	Yes
6.	F. McD.	F	29	Yes	2½ years	Backache and right sciatica.	Hollow back. Spinal motions free. Tenderness at lumbosacral junction.	—	+	Yes
7.	J. S.	F	43	No	6 months	Backache. Right sciatica. Numbness of outer part of right foot.	Increase in lumbar hollow. Restriction of lumbar movements. Tenderness at lumbosacral junction.	—	+	No
8.	J. P.	M	33	No	5 years	Backache. Pains in both lower limbs. Difficulty in walking.	Stiffness of lumbar spine. Tenderness at lumbosacral junction.	—	+	No
9.	T. T.	M	34	No	10 months	Backache.	Negative.	—	+	No

## SYMPTOMATOLOGY AND FINDINGS IN NINE CASES OF PRESONDYLOLISTHESIS

Backache was the chief complaint in all cases.

Sciatic pain was present in five cases.

Lordosis was found in four cases.

The neurological examination was negative in all cases.

Roentgenograms showed characteristic laminar defect in all but one case.

An operation was performed in five cases, all of which showed bilateral osseous defect of neural arch of last lumbar vertebra.

Four of the five patients who were operated on were relieved of their symptoms. The remaining patient is still in the hospital.

Although as yet there has not been recorded a case of prespondylolisthesis in which a dislocation of the affected vertebral body subsequently took place, the author believes that Dr. Armitage Whitman was correct in initiating this term and suggesting the existence of a lesion that is, in the light of our present knowledge of the anatomy of the lumbosacral area, undoubtedly the direct antecedent of a spondylolisthesis. Now that many orthopaedic surgeons are more carefully studying derangements of the back, it is but a matter of time when the sequence of a prespondylolisthesis—an injury, a dislocation of the body of the vertebra—will be witnessed and recorded.\*

## SUMMARY

1. Prespondylolisthesis is a competent cause of backache and back disability.
2. Prespondylolisthesis is the forerunner of a spondylolisthesis.
3. Prespondylolisthesis may remain asymptomatic for many years, or throughout life.
4. The most active period of life, thirty to fifty years, has shown the largest incidence of prespondylolisthesis in the author's group.
5. The chief clinical features of prespondylolisthesis are: (a) low back pain; (b) stiffness of back; (c) sciatic pain; (d) localized tenderness at the lumbosacral area. Lordosis is often present, but is not a constant finding.
6. The essential pathological lesion is a bilateral defect in the neural arch at the pedicles.
7. The most effective treatment is surgical, consisting of a fusion of the lower three lumbar vertebrae to the sacrum.

\* It may be premature and even unwarranted to use the term prespondylolisthesis as expressing confident anticipation that a dislocation or spondylolisthesis will eventuate in the type of lesion herein described. However, a better term does not occur to the author and has not been suggested by anyone else, while the term prespondylolisthesis has already been used fairly extensively in both the English and German languages and may conveniently be applied to the clinical syndrome reported.

# FRACTURES OF THE ANKLE: RECENT AND OLD \*

BY MELVIN S. HENDERSON, M.D., AND WALTER G. STUCK, M.D.,  
ROCHESTER, MINNESOTA

*Section on Orthopaedic Surgery, The Mayo Clinic*

Fracture of the ankle comprises a good portion of the total number of fractures seen in any emergency service. Some recent articles on the subject are reviewed in the following table.

TABLE I  
SUMMARY OF RECENT LITERATURE

Author	Cases	External Malleolus Alone	Both Malleoli	Internal Malleolus Alone	Posterior Malleolus With or Without Other Injuries
		<i>Per Cent.</i>	<i>Per Cent.</i>	<i>Per Cent.</i>	<i>Per Cent.</i>
Speed (1914)	208	28.7	22.6	4.8	7.7
Colvin (1914)	60	26.6	45.0	6.6	5.0
Ashhurst and Bromer (1921)	300	35.3	19.0	6.6	19.0
Platt <i>et al.</i> (1926)	116	28.0	55.0	12.0	3.0
MacKinnon (1928)	100	43.0	28.0	7.0	10.0
Ollerenshaw (1929)	100	44.0	29.0	14.0	7.0
Henderson (1931)	82	30.5	37.8	14.6	12.2
Bishop (1932)	300	36.3	45.0	15.6	13.0
Total	1,266	34.0	35.2	10.1	9.6

## REVIEW OF CASES

For this survey, we have reviewed the histories of all the patients with fracture of the ankle treated in the Orthopaedic Section of The Mayo Clinic from 1909 to 1933. Patients seen within three weeks of the time of injury were considered as having fresh fractures, and all others as having old fractures. There was a total of 479 patients, of whom 139 had recent fractures of the ankle and 340 had old fractures.

Patients with recent fractures usually came to the hospital in emergency, but those with old fractures presented themselves because of the following symptoms, in the order named: (1) persistent pain in the ankle; (2) swelling; (3) limitation of motion; (4) deformity; or (5) weakness; or, they suffered from a combination of several of these complaints.

In all of these cases of recent and old fractures the mode of injury was interesting. Of the 139 recent fractures, thirty were produced by a fall from a height, twenty-three by slipping on the ice, eighteen by a direct blow on the ankle, eleven by automobile accidents, six by jumping

\*Read before the American Orthopaedic Association at Washington, D. C., May 11, 1933.

from a runaway team, and the remaining fifty-one were produced by miscellaneous causes,—such as twisting ankle, tripping on stairs, and stepping in a hole. Of the 340 old fractures, ninety-two were produced by a fall from a height, forty-four by a direct blow to the ankle, twenty-nine by jumping from a runaway team, twenty-seven by slipping on the ice, eleven by automobile accidents, and the remaining 137 by twisting the ankle, tripping on stairs, stepping in a hole, and so forth.

Comparison of these figures reveals that the patients who came because of old fractures with persistent symptoms had suffered more severe types of injuries,—such as falling from a height or jumping from a runaway team. The incidence of injury sustained by slipping on the ice was two and a half times more common in cases of recent fracture. This was explained by the fact that all patients with recent fractures came from the vicinity of The Mayo Clinic,—that is, the north central part of the United States where there is ice during the long winters. Also a much higher percentage of old fractures were compound. As a consequence, these cases were complicated by more serious permanent injury to the bony components of the ankle joint.

TABLE II  
RECENT FRACTURES OF THE ANKLE—139 CASES\*  
(LESS THAN THREE WEEKS AFTER INJURY)

Site of Fracture	No. of Cases	Per Cent.
A. Fracture of the malleoli		
1. Isolated		
a. Fibula (external malleolus)	29	20.9
b. Internal malleolus	15	10.8
2. Combined		
a. Low bimalleolar without displacement of talus	24	17.2
b. Bimalleolar with outward displacement of talus (Pott's)	28	20.1
B. Fracture of the weight-bearing surface of the tibia		
1. Isolated		
a. Posterior malleolus	3	2.1
b. Anterior margin	0	0.0
2. Combined		
a. Fracture of both malleoli and posterior malleolus of the tibia (trimalleolar, Pott's)	23	16.5
b. Anterior marginal or posterior fracture of the malleolus associated with fracture of one malleolus	10	7.2
C. Fracture of the astragalus		
1. Isolated	7	5.0
2. Combined†	(7)	
Total	139	
	(4 were compounded)	

\* The Mayo Clinic.

† Combined astragalus fractures were associated with one of the foregoing malleolar fractures. These cases were so tabulated because the malleolar fracture was the dominant injury. (April, 1933.)



Another common condition in the old cases was diastasis of the lower third of the tibia and fibula, with rupture of the tibiofibular ligament. This distortion of the ankle joint often led to dislocation of the astragalus upward and outward, due not only to the diastasis but also to injury to the outer margin of the weight-bearing surface of the tibia. If such injury is extensive, permanent disability ensues.

In order to tabulate our cases according to the types of fracture we have adapted in principle the outline classification as devised by Tanton. It is simple, logical, and well suited to a clear presentation of a large group of cases.

TABLE III  
OLD FRACTURES OF THE ANKLE—342 CASES\*  
(MORE THAN THREE WEEKS AFTER INJURY)

Site of Fracture	No. of Cases	Per Cent.
A. Fracture of the malleoli		
1. Isolated		
a. Fibula (external malleolus)	27	7.9
b. Internal malleolus	21	6.1
2. Combined		
a. Low bimalleolar without displacement of talus	68	19.9
b. Bimalleolar with outward displacement of talus (Pott's)	115	33.6
B. Fracture of the weight-bearing surface of the tibia		
1. Isolated		
a. Posterior malleolus	2	0.6
b. Anterior margin	8	2.3
2. Combined		
a. Fracture of both malleoli and posterior malleolus of the tibia (trimalleolar, Pott's)	56	16.3
b. Anterior marginal or posterior malleolar fracture associated with fracture of one malleolus	16	4.6
C. Fracture of the astragalus		
1. Isolated	29	8.4
2. Combined†	(23)	
Total	342	
	(34 were compounded; 2 were bilateral in the same patient)	

\* The Mayo Clinic

† Combined astragalus fractures were associated with one of the foregoing malleolar fractures. These cases were so tabulated because the malleolar fracture was the dominant injury. (April, 1933.)

#### FRACTURES WITH DISPLACEMENT (POTT'S FRACTURES)

For convenience these classifications can be combined on a clinical basis and thus the relative frequency of certain types of fracture can be compared at a glance. Clinically Pott's fracture is a bimalleolar fracture with displacement, or, as Platt has described it, "those fractures of

TABLE IV  
COMPARISON OF FREQUENCY OF CERTAIN TYPES OF FRACTURE

Type of Fracture	Fresh Fractures 139 Cases	Old Fractures 340 Cases
	<i>Per Cent.</i>	<i>Per Cent.</i>
Bimalleolar fractures with deformity	20.1	33.6
Trimalleolar fractures	16.5	16.3
Total Pott's fractures	36.6	49.9
Fracture of external malleolus alone	20.9	7.9
Fracture of internal malleolus alone	10.8	6.1
Fracture of the astragalus	10.0	15.1
Compound fractures	2.9	9.9

the lower 3 inches of the fibula, which are accompanied by rupture of the internal lateral ligament or fracture of the internal malleolus, and in which there is the slightest degree of deformity at the ankle-joint—either eversion alone or eversion combined with posterior displacement of the foot". In this summary we shall, therefore, group all bimalleolar fractures of this type together as Pott's fractures.

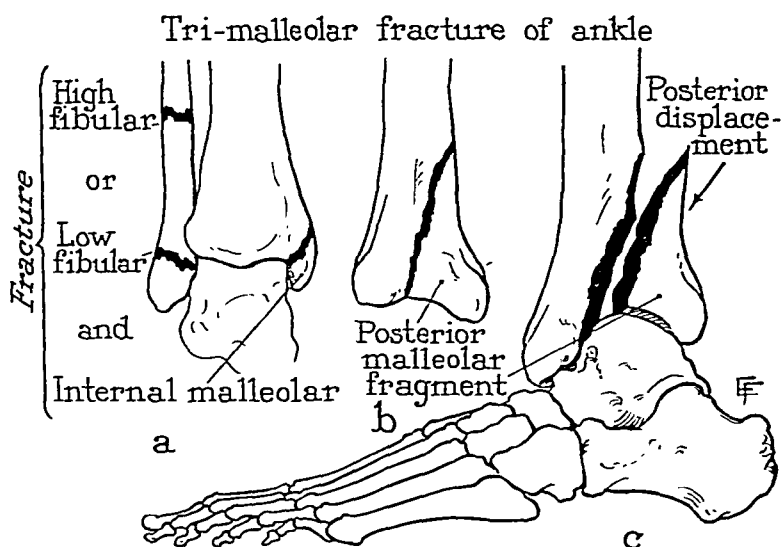


Fig. 1

The trimalleolar fracture, as identified and described by one of us (Henderson), consists of the clinical Pott's fracture, as mentioned, plus fracture of the posterior malleolus with encroachment on the weight-bearing surface of the tibia. It is usually accompanied by posterior and upward dislocation of the astragalus which manifests itself clinically as posterior displacement of the foot. This is not a new type of fracture, but the term "trimalleolar" is new and is offered as a descriptive name for an old fracture. It seems to describe tersely the lesion present in one of the most serious and disabling fractures of the ankle joint.

The posterior margin of the weight-bearing surface of the tibia, the posterior malleolus, projects well down over the posterior aspect of the astragalus and, in fact, is essential to prevent backward displacement of this bone. In addition, the astragalus is firmly connected with the external malleolus (the lower tip of the fibula) by a strong dense ligament, the posterior band of the external lateral ligament. This band never ruptures when injury is sustained, so that the astragalus and external malleolus are displaced together when fracture of the external malleolus takes place. This helps to explain the more frequent association of fractures of the internal and external malleoli when the posterior malleolus is fractured. In fact it is justifiable, when definite posterior dislocation of the foot is present, to assume that there is a trimalleolar fracture of the ankle.

#### CLINICAL CONSIDERATIONS AND TREATMENT

The diagnostic signs of uncomplicated fracture of the ankle are so obvious and so well known as to need no mention here. But a review of this type, with comparison of fresh and old fractures, emphasizes the importance of early accurate diagnosis. A certain percentage of fresh fractures gives little evidence of deformity at the time of injury. Therefore, the presence of pain and disability after any injury to the ankle demands careful consideration to prevent mistaken diagnoses. Too often, permanent disability may follow injury casually dismissed as a "sprain" in which roentgenograms are not taken. The swelling that may develop shortly after injury may mask even considerable bony displacement.

#### RECENT FRACTURES

The treatment of recent fractures is essentially conservative. Isolated malleolar fractures without displacement may be adequately treated by splinting or strapping. But in cases of deformity the method of choice is manipulation into corrected position and complete immobilization in a plaster cast.

Roentgenograms before and after reduction should always be taken in two planes. In the anteroposterior view the normal slight convexity of the weight-bearing surface of the tibia should fit accurately into the normal concavity of the superior articular surface of the astragalus. In the lateral view the converse is true. The convexity of the superior articular surface of the astragalus should fit accurately into the concave weight-bearing surface of the tibia. When these surfaces fit, as seen in the roentgenograms, the fracture is accurately reduced.

In sixteen of our 139 cases of recent fracture of the ankle, open operation was necessary. The replacement of a malleolus, usually the internal malleolus, by suturing or by the use of bone screws was necessary in cases in which there was considerable irreducible displacement of the fragments. Only one trimalleolar fracture was operated on. Even with considerable comminution of the weight-bearing surface of the tibia and the

resultant prolonged convalescence, an excellent result was ultimately obtained if the first reduction was proper and the line for weight-bearing accurate. On the other hand, as will be shown, when considering old fractures, neglect of this early accurate reduction leads to prolonged or permanent disability.

#### OLD FRACTURES

Patients with old fractures of the ankle came to the Clinic because of pain, swelling, limitation of motion, deformity, or weakness, or combinations of these symptoms. In the 340 cases in which there were 342 old fractures, operation was performed in 121 cases, osteotomy of both malleoli in forty, manipulation in sixteen, Achilles tenotomy in fourteen, astragalectomy in thirteen, removal of fragments or exostoses in twelve, "open reduction" in seven, wedge osteotomy in five, arthrodesis of the ankle in five, amputation in five, and bone graft to the malleoli in four.

In 219 cases conservative recommendations were made because the symptoms were not severe or because the injury was so great that there was little chance of improving function by surgical procedures.

In many of the cases of old fracture roentgenograms had not been made at the time of accident or later. However, in all fairness to the physicians who had seen these patients, there were many contributing factors,—such as inaccessibility to roentgen-ray equipment, and unwillingness of patients to submit to the examination. Furthermore, in many cases there was evidence of such severe injury to bone that any type of treatment would have given poor end results. Yet, even in cases of old fracture with marked deformity, it was often surprising, after treatment, to note the painless useful ankle which eventually resulted after years of disability. Improvement takes place slowly over a long term of years, and what had at first seemed to be a permanent and extensive loss of function finally resolved into comparatively little loss of function.

#### CONCLUSIONS

This review of 479 fractures of the ankle, comprising 139 recent fractures and 340 old fractures, emphasizes once more the importance of correct reduction to secure a sound useful ankle. Likewise it demonstrates that failure to effect perfect reduction through delay or failure to recognize the lesion inevitably leads to poor results and a high percentage of disability.

The trimalleolar fracture, in particular, with both lateral and posterior displacement of the foot if not reduced, is more likely to produce serious disability than is the bimalleolar type of fracture with only lateral displacement. Posterior displacement of the entire foot causes grave incapacity if uncorrected, and, even with operation later, its evil results are seldom rectified. Unlike the trimalleolar, the old bimalleolar fracture with valgoid deformity can often be successfully corrected by osteotomy if diastasis with injury to the outer border of the tibial pilon is not present.

The injury referred to is produced by diastasis of the tibia and fibula, with resulting rupture of the tibiofibular ligament and perhaps injury to the external margin of the tibia. The normal relation between the astragalus and the weight-bearing surface of the tibia is disrupted and, even with late corrective operation, there is a low percentage of satisfactory results.

We see, therefore, that corrective surgical measures on the improper results from old fractures of the ankle are far less important than early, accurate reduction followed by careful, adequate immobilization, and that the patient's ultimate happiness depends most on the physician who cares for him at the time of his injury.

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## RECURRENT DISLOCATION OF THE JAW \*

BY LEO MAYER, M.D., NEW YORK, N. Y.

Under this title two distinct pathological lesions have been included in the past,—one of them a genuine dislocation, the other an internal derangement usually associated with an abnormality of the interarticular fibrocartilage. Failure to analyze cases carefully has resulted in considerable confusion as emphasized by the number of different procedures, both non-operative and operative, which have been recommended for the cure of the condition.

Many patients complain of a slight sensation of snapping in the region of the temporomandibular articulation. This symptom has frequently been considered a neurotic manifestation. So far as can be decided from the superficial study accorded these cases, there is no specific pathology to explain them. They are usually cured by temporary fixation of the jaw, either by a bandage or splint. In a larger group of cases snapping is definitely due to malocclusion of the teeth and is readily cured either by filing down the offending molars or by other adjustments of the teeth. After excluding these two groups of cases, there remains a third group which is not due to neurotic tendencies or to malocclusion of the teeth, but to some intra-articular peculiarity of the temporomandibular articulation itself. It is with this group that this paper deals.

It is unnecessary to review in detail the anatomy of the temporomandibular articulation. It consists essentially of the condylar process of the jaw articulating with the temporal fossa of the temporal bone. The fossa is bounded in front by the eminentia articularis which normally forms a sufficient projection to prevent undue excursion of the jaw. Lying between the condylar process and the temporal fossa is the interarticular fibrocartilage,—a thin, fibrous plate which is attached quite closely to the condyle of the jaw and divides the articulation into a larger upper portion and a smaller lower portion. Both of these are lined with synovial membrane. Anteriorly the external pterygoid muscle is attached to the interarticular fibrocartilage. The joint is closed by a capsule which is reinforced by a number of accessory ligaments.

During the past few years it has been the author's good fortune to study five cases of slipping at the temporomandibular articulation. Operative procedures were carried out on four of these patients, affording him an unusual chance of studying accurately the underlying pathology. In three of the patients this was seen to be a genuine dislocation of the condyle of the jaw. When the mouth was opened, the condyle slipped forward over the eminentia articularis, lodging in an anterior position. In the fourth case no such dislocation occurred; the lesion was due entirely to an

\*Read at the Annual Meeting of the American Orthopaedic Association, Washington, D. C., May 9, 1933.

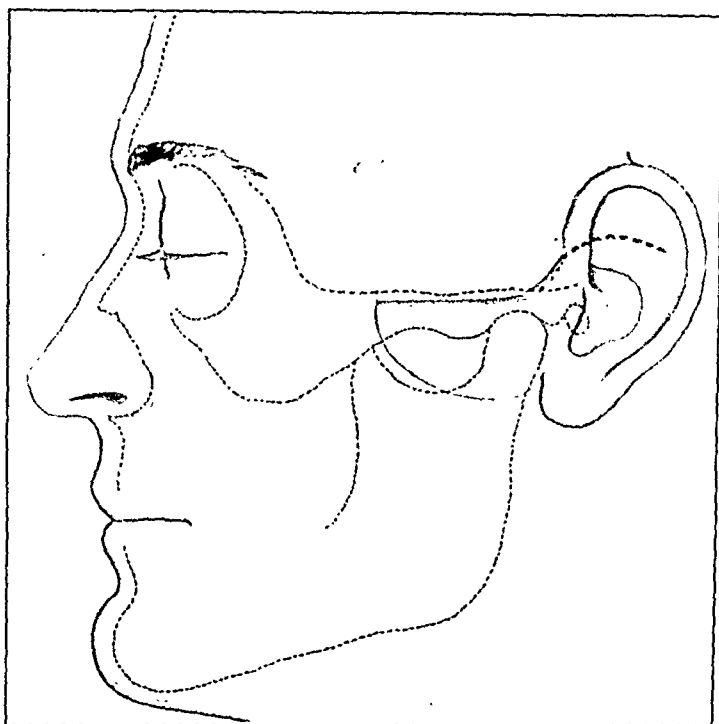


FIG. 1

Photograph of model illustrating the line of incision for bone-block operation.

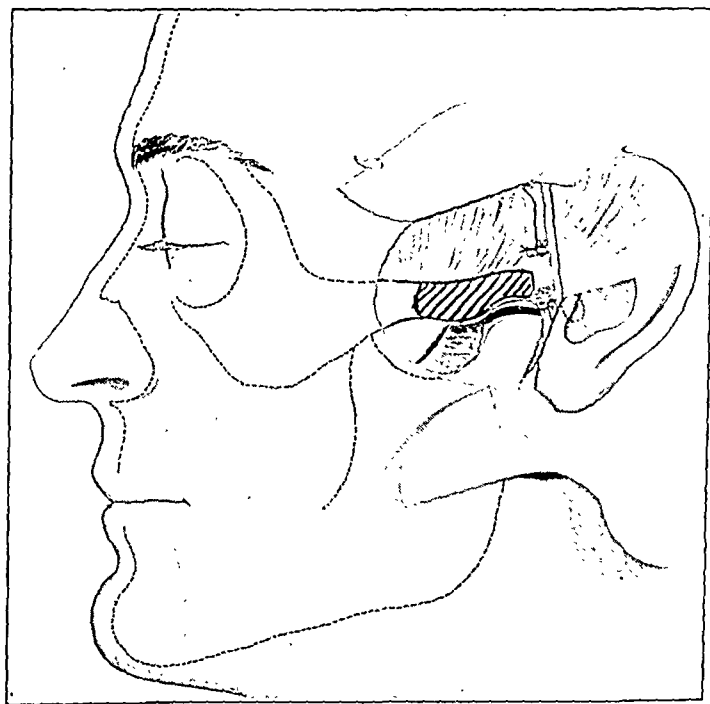


FIG. 2

Second step of bone-block operation. The superficial temporal vessels have been ligated, the nerve retracted posteriorly. The portion of the zygoma to be resected has been shaded. The interarticular fibrocartilage is shown in black.

abnormal laxity of the interarticular fibrocartilage. This case was treated simply by the removal of the meniscus, a method already practised by Ashhurst, Dufourmentel, and other surgeons. The other three cases, in which an actual dislocation occurred, required a more radical procedure.

Two methods for the cure of recurrent dislocation have already been published. First, that of Nieden, consisting of the transplantation of a strip of the temporal fascia, which is attached to the condyle of the jaw with sufficient tension to prevent the dislocation from recurring. Second, the method proposed by Konjetzny, in which the interarticular fibrocartilage is freed posteriorly and is lodged in the anterior portion of the joint in such a way as to form a buffer preventing the dislocation. Although both authors have reported satisfactory results, it seemed that the dislocation could best be

prevented by the bone-block method which has been so effective in overcoming genu recurvatum and drop-foot, since this method would actually correct the pathology,—namely, the excessive shallowness of the temporal fossa.

The operation is best performed under local anaesthesia. It is done through a two-inch horizontal incision running along the zygomatic process almost to the external auditory meatus, then gently upward and backward over the base of the pinna of the ear (Fig. 1). This incision was at first believed to be original, but it has already been used by Burdick, though not published by him. It has the advantage over the short horizontal and angular incisions of Murphy, Henderson, and others in that it gives an unusually good approach to the joint. This is done by turning the pinna of the ear downward, thus exposing the zygomatic process from its base

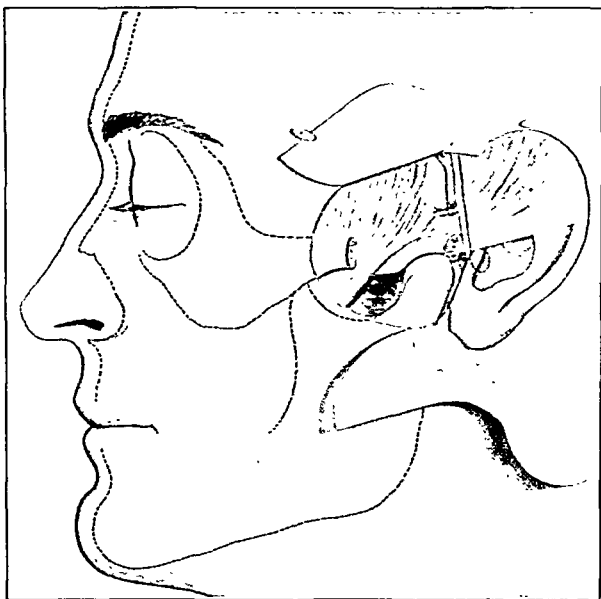


FIG. 3

Third step of the bone-block operation. A portion of the zygoma has been resected exposing the entire temporomandibular articulation. The interarticular fibrocartilage has been removed.

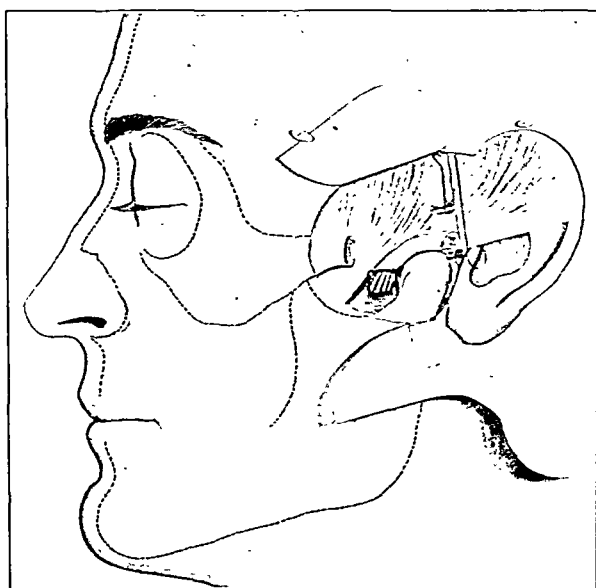


FIG. 4

Fourth step of bone-block operation. The bone graft has been mortised into the temporal bone just anterior to the eminentia articularis. The projecting portion of the bone graft has been shaded.



posteriorly to a point anterior to the temporomandibular joint (Fig. 2). This approach has one disadvantage; it necessitates the division of the superficial temporal vessels, which run vertically just anterior to the ear, and also necessitates strong retraction of the superficial temporal nerve, a branch of the fifth cranial nerve supplying sensation to the lateral portion of the forehead. Even though the nerve is cut or injured, however, the sensory loss is so slight as to be of little practical significance. About one inch of the zygomatic process is cut away with the motor saw or with any suitable bone-cutting instrument (Figs. 2 and 3). This at once exposes the temporomandibular joint. The capsule of the joint is divided by a transverse incision or by a transverse combined with a vertical. It is then possible to study the exact pathology of the particular case. The patient is asked to open the mouth and during this act the motions of the condyle and of the interarticular cartilage can be accurately observed. In one of the four cases operated upon the pathology was due entirely to a loose cartilage and as soon as this had been removed the snapping stopped. In the other three cases, despite preliminary removal of the meniscus, the condyle could be seen slipping forward over the eminentia articularis as the mouth was opened. To prevent the slipping from occurring the resected portion of the zygomatic process is utilized as a bone graft and inserted just anterior to the eminentia articularis. A vertical groove exactly corresponding in size to the width of the bone graft is cut in the temporal bone. Its depth should correspond to the thickness of the graft (usually about one-eighth of an inch). The groove is about one-half an inch long, permitting one-half of the graft to project downward (Fig. 4). In cutting the groove, the edges should be made slightly oblique so that the graft will be firmly mortised in place when driven into position. No fixation sutures are necessary. When the graft is in place the patient is again allowed to open the mouth and if the technique has been correct a slipping will be prevented by the bone graft. The operation is then completed by a careful suture of the capsule of the joint, closure of the fascia and of the skin. That portion of the zygomatic process which was resected for the exposure of the joint is usually just the right size for the bone block. It is unnecessary to replace the resected zygoma since this defect is not noticeable either in the appearance of the face or the function of the jaw. Great care must be taken in this operation, as in all operations on the temporomandibular joint, not to injure the branches of the facial nerves which cross upward over the anterior portion of the zygomatic process. Morris has pointed out that, since these branches are running deep to the fascia, injury can be made less probable by thorough retraction of the temporal fascia. At the conclusion of the operation a plaster-of-Paris helmet, completely encasing the head, is applied so as to prevent motion of the jaw until the graft has healed in place. Thus far immobilization of from four to six weeks has proven adequate. The patients are given a liquid diet for the first ten days. It has not been necessary to remove teeth for feeding, since the plaster, though snug, permits

the passage of a glass tube between the teeth. After ten days the patients are able to open the teeth sufficiently to eat soft food.

Thus far the bone-block method has been used in three cases. In all three the condition of slipping caused marked disability not alleviated by careful non-operative treatment. In all three cases the bone-block method has been successful.

A synopsis of the three cases follows:

CASE 1. K. F., No. 15191, aged twenty-seven years, was admitted July 19, 1927, discharged September 2, 1927. For many years the patient had had a recurrent dislocation of the left jaw which occurred whenever he laughed or yawned and frequently during the act of eating. Pain was a comparatively slight symptom, but the patient was much annoyed by the loud snapping sound and the necessity of reducing the dislocation. Examination showed nothing abnormal except a dislocation of the jaw whenever the patient opened his mouth. A bone-block operation was performed July 27, 1927. The plaster was removed August 18. The patient was given physiotherapy and allowed to leave the hospital September 2. Two years later there had been no recurrence of the dislocation; there was almost normal motion of the joint. A small area of hyperaesthesia over the lateral aspect of the left forehead was still present.

CASE 2. B. S., No. 17221, aged twenty-two years, was admitted January 26, 1928, discharged February 7, 1928. Onset of condition occurred three years before without any apparent cause. The patient complained chiefly of pain in the region of the left temporomandibular joint. A few months later the first dislocation was noted. Recurrences then became more and more frequent, and at the time of the examination the patient was having a dislocation almost every day. Examination was negative except for tenderness in the region of the left temporomandibular joint. When the patient opened the mouth the condyle slipped out of the temporal fossa. A bone-block operation was performed January 27, 1928. At follow-up, one year later, the patient reported that there had been no recurrence of the dislocation. For several months there was a restriction in the motion of the jaw limited not only to opening and closing, but also to lateral motion. This gradually disappeared by means of exercises and manipulation until one year after operation there was normal motion of the jaw.

CASE 3. G. S., No. 42025, aged twenty-six years. For many years the patient has been suffering from a slipping of the left temporomandibular joint. During the last few months slipping has occurred each time the patient opens her mouth, causing her great pain and discomfort. Examination shows typical dislocation of the mandible whenever the patient opens the mouth. This is confirmed by roentgenograms of the mouth with the joint closed and open (Fig. 5). A typical bone-block operation under local anaesthesia was performed on March 20, 1933. Immediately after the bone block had been mortised into position the patient was unable to dislocate the jaw. Plaster-of-Paris was removed after four weeks. Roentgenograms showed good position of the bone block (Figs. 6 and 7). Three months after operation the patient was able to open the mouth to the normal limit. She had no pain and there had been no recurrence of dislocation.

The fourth operative case, in which the lesion was entirely confined to the interarticular fibrocartilage and was cured by the removal of the cartilage, is as follows:

CASE 4. E. E., No. 24357, aged eighteen years, was admitted September 16, 1929, discharged September 27, 1929. For one and a half years the patient had been complaining of a clicking in the region of the right temporomandibular joint, occasional inability to open or close the mouth, and pain in the region of the joint. The patient believes that her symptoms started when she was given a hard slap on the right side of the face. Immediately following the blow she was unable to close her mouth and felt severe pain in the region of the temporomandibular joint. By pushing the jaw toward the right side



FIG. 5-B



FIG. 5-A

Roentgenograms of Case 3 before operation. The outlines of the jaw and of the temporal fossa have been traced in white ink for purposes of reproduction.

1. Condylar process. 2. Eminentia articularis.

The roentgenogram at the left was taken with the mouth closed and shows the condylar process within the temporal fossa. The roentgenogram at the right was taken with the mouth open and shows the condylar process dislocated forward, lying in a position just anterior to the eminentia articularis.



FIG. 7

Roentgenogram of Case 3, four months after operation, with the mouth open. It is seen that the bone block effectually prevents the condyle of the jaw from dislocating.

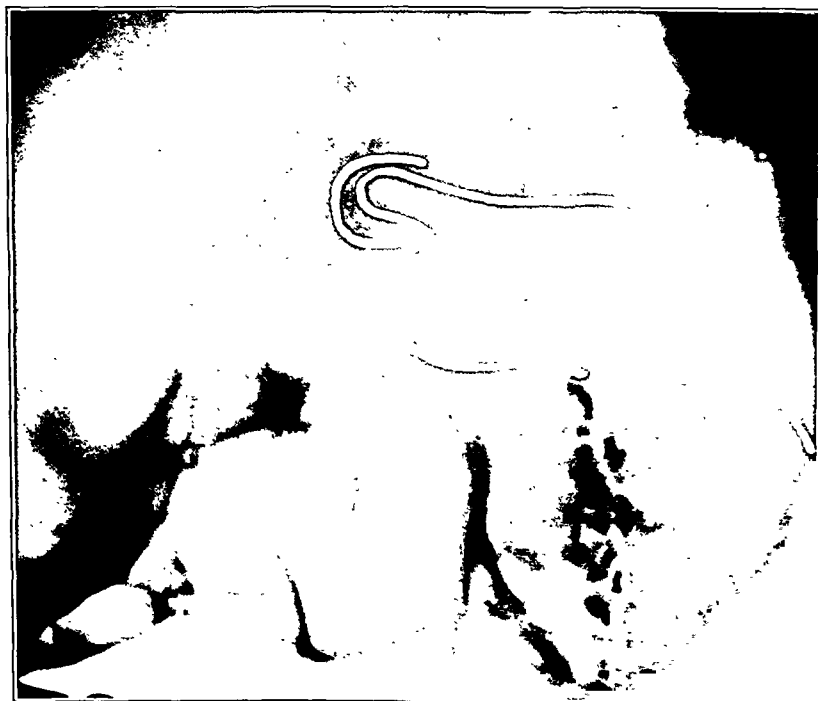


FIG. 6

Roentgenogram of Case 3, four months after operation, with the mouth closed. The deepening of the temporal fossa by means of the bone block is clearly seen.

she was able to close it. Since that time the slipping had become more and more frequent.

Examination showed no abnormality except a snapping sensation in the region of the right temporomandibular joint when the mouth was opened and closed. The patient voluntarily could make the jaw lock and then release it. No definite dislocation could be palpated nor could it be demonstrated by roentgenograms of the joint. An operation was performed September 18, 1929. On opening the joint the interarticular fibrocartilage was found detached in large part from the condyle. This gave it an abnormal degree of mobility. It was readily removed by cutting its anterior and posterior attachment to the condyle. The temporal fossa appeared to be normal. After removal of the cartilage the patient could open and close the mouth without any snapping. Plaster-of-Paris was applied as in the bone-block operations and left in place for three weeks. There has been no recurrence of the snapping; pain disappeared and has not recurred.

#### SUMMARY

Intractable slipping at the temporomandibular articulation may be due either to a lesion of the interarticular fibrocartilage—corresponding to a lesion of the internal meniscus of the knee—or to an actual dislocation of the condyle which slips forward over the eminentia articularis. The former group can be cured by the simple removal of the meniscus. For curing the latter group, a new operation is described, consisting in the construction of a bone block just anterior to the eminentia articularis. Four cases of cure are cited,—one of the first group, three of the second.

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# INSTABILITY OF THE KNEE JOINT DUE TO INJURY OF THE ANTERIOR CRUCIAL LIGAMENT

## A REPORT OF ELEVEN OPERATED CASES \*

BY ARTHUR KRIDA, M.D., F.A.C.S., NEW YORK, N. Y.

Injuries to the crucial ligaments are sustained when the knee is subjected to gross dislocation or subluxation, or by the exaggeration of the type of traumatism that produces injuries to the semilunar cartilages. Either or both ligaments may be the seat of rupture, or the traumatism may result simply in attenuation and stretching. Injury to the anterior crucial ligament is by far the more common, only a few cases of posterior crucial injury having been reported in the literature.

That recovery from such injuries may result in a functionally useful and stable joint admits of no question. It must be assumed that when such functional recovery occurs the stability of the joint is determined by the integrity of the quadriceps extensor muscle and its fascial expansions. Therefore it should be stated that cases of acute injuries to these ligaments are not suitable for plastic repair.

Not infrequently, however, following such an injury, the knee joint becomes the seat of a chronic instability. The instability may be general in character,—that is, in the lateral as well as in the anteroposterior planes; or the instability may be specific with regard to the particular ligament involved. The characteristic instability associated with injury to the anterior crucial ligament consists of the ability to displace the tibia forward on the femur in the attitude of extension or of slight flexion. The characteristic instability associated with damage to the posterior ligament consists in the ability to slide the tibia backward on the femur in the flexed position.

A patient with a chronic knee-joint instability based upon such injuries is very much disabled. The usual alternatives with which he is faced are: (1) permanent brace wearing; (2) arthrodesis; (3) the prospect of operative reconstruction of the damaged ligament.

The historical summary of the attempts at surgical repair of these ligaments prior to 1917 is contained in the paper of Hey Groves.<sup>1</sup> These consist in the main of direct suture of the ligaments or of the reattachment of avulsed bony fragments bearing the ligament. In 1917, Hey Groves<sup>2</sup> described a fascioplasic repair based upon entirely new conceptions. The principles involved in the Hey Groves operation consist of: (1) the use of fascia lata to replace the ligament; and (2) the firm anchorage of the reconstructed ligament in bone tunnels drilled through the femur and the tibia. In the writer's opinion, these principles have served to establish

\* Read before the American Orthopaedic Association at Washington, D. C., May 11, 1933.

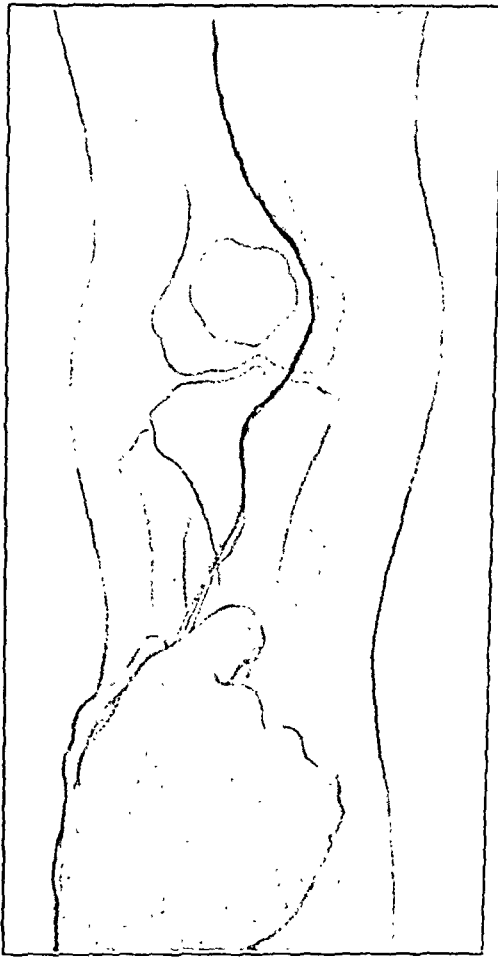


FIG. 1  
General utility incision for exploration of knee joint.

firmly the operative treatment of these injuries.

The Hey Groves operation for the repair of the anterior crucial ligament is done through a J-shaped incision, the long arm extending upward on the lateral aspect of the thigh and the curved portion cutting across the anterior joint structures. A one-quarter-inch drill hole is made in the outer condyle of the femur to emerge in the intercondyloid notch. A similar drill hole is made in the inner tuberosity of the tibia to emerge somewhat anterior to the normal site of the insertion of the anterior crucial ligament. A long strip of fascia lata, about one to one and one-half inches in width, is then reflected downward and allowed to remain attached at its lower pole. This is introduced into the joint and is then passed through both drill holes and, with the knee in slight flexion and the fascial strip under tension, is attached to the periosteum of the head of the tibia. Alwyn Smith<sup>3</sup> added a valuable feature to

the operation by using a somewhat longer strip of fascia and, after suture to the tuberosity of the tibia, reflecting the end of the fascial strip upward onto the inner condyle of the femur, thus reconstructing an internal lateral ligament.

The writer's experience has been entirely with the repair of the anterior crucial ligament, no case of posterior crucial ligament having come under his observation. The above described combined operation has been modified by the writer in the following manner:

(1). The joint is opened by what has been described as a general utility incision for the exploration of the knee joint.<sup>4</sup> This incision begins in the mid-line well above the patella, curves downward along its inner border, and passes downward along the side of the patellar ligament. The capsule is opened in the same plane.

(2). The fascia is secured through a separate incision on the outer side of the thigh.

(3). The method of attaching the reconstructed lateral ligament to the condyle is a modification of the Alwyn Smith procedure. Instead of fastening it through drill holes, this strip is anchored to the femur

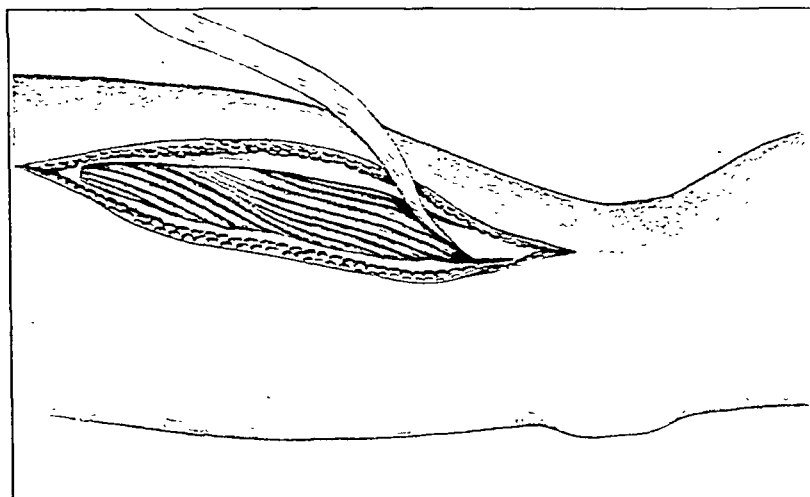


FIG. 3

A long strip of fascia lata is secured and allowed to remain attached at its lower pole.

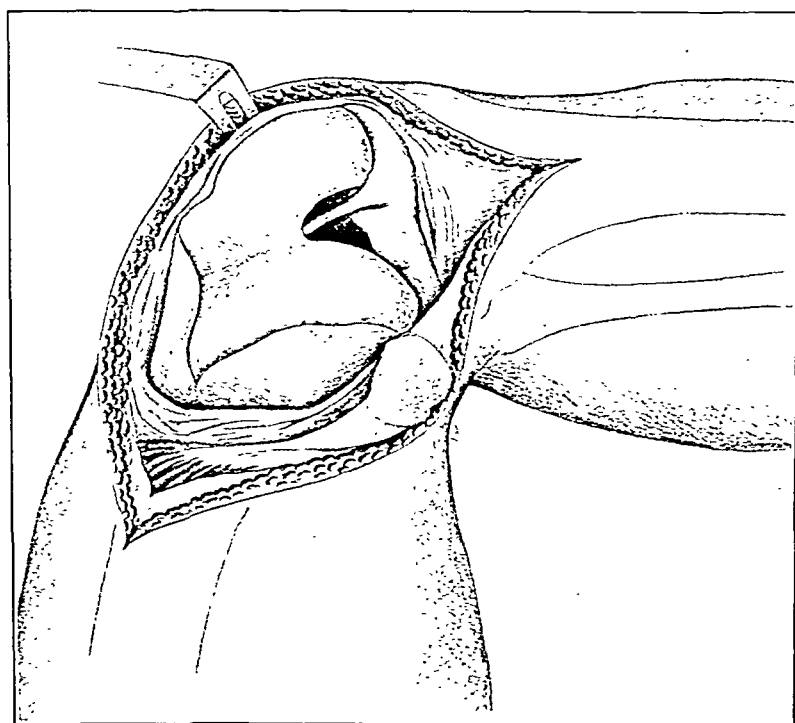


FIG. 2

Knee joint exposed, showing thinned, frayed-out, anterior cruciate ligament.



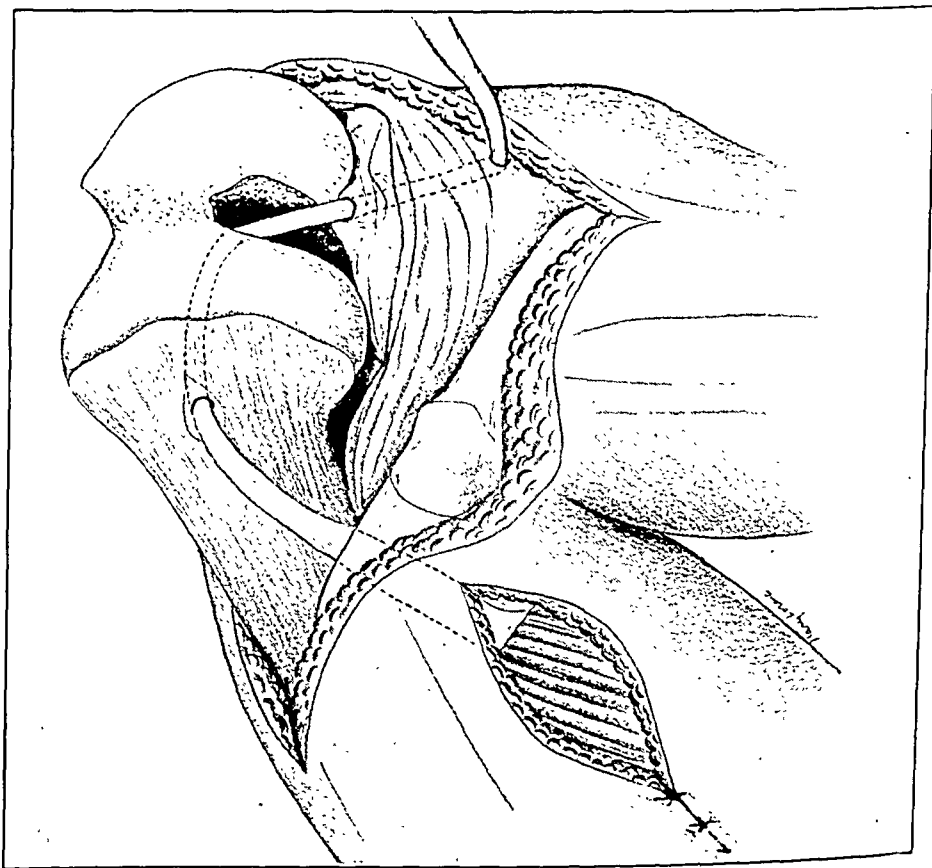


FIG. 4  
Course of fascial strip through bone tunnels of knee joint.

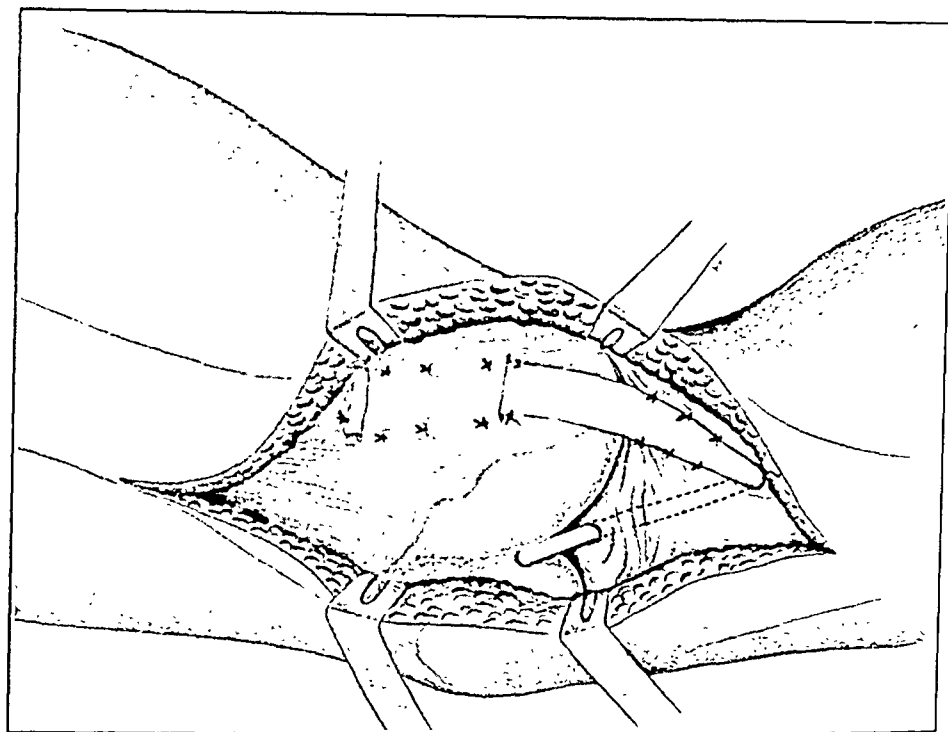


FIG. 5  
The end of the fascial strip is used to reconstruct the lateral ligament.

subperiosteally. Two small transverse incisions are made down to the bone and the periosteum between them is lifted up. The strip is passed through the incisions beneath the periosteum, and sutured to the soft parts.

The after-treatment consists of relative immobilization in a Thomas splint with the knee in slight flexion. Exercises of the quadriceps are encouraged from one week after the operation. The patient begins to mobilize his knee at the end of four weeks and is allowed to walk without a brace or other support at the end of six weeks.

During the last eight years, the author has operated upon eleven patients for the reconstruction of the anterior crucial ligament. The youngest patient was eighteen; the oldest, forty-three. There were ten men and one woman. All the patients except two were very much disabled prior to operation; in general they required the use of a brace or were able to get about only with the aid of a stick. In one case the ruptured ligament was discovered during an exploratory operation for internal derangement; one other patient had a "trick knee",—he could voluntarily slide the tibia forward upon the femur to the extent of one inch, although the knee was otherwise stable and did not require the use of a support. Two cases presented the additional symptom of hyperextension to about twenty-five or thirty degrees.

There were no infections nor any postoperative complications in the series. At operation, the anterior crucial ligament was found to be completely ruptured in three cases; in the remainder, varying degrees of attenuation and relaxation were noted.

In discussing the results obtained in this series, it may be stated that the evaluation of a result should not ordinarily be made under six months, since these knees improve in range of motion and in strength up to that time, and even later. One case is classed as a failure,—a confirmed compensation case, in which the patient was a negro thirty-six years of age who had worn a long brace for two years, and whose knee joint presented moderately advanced osteoarthritic changes. Even though he obtained a good range of motion and a stable knee, he continued to complain of disability, and the result was therefore classed as a failure. One patient left the country at the termination of his hospital stay, which happened to coincide with a lump sum settlement of his case. It has not been possible to follow him. One patient was operated upon ten weeks ago, and the operation promises to be successful.

The remaining eight cases are classified as good results. The patients have stable, painless knees with substantially complete ranges of motion, except one in whose knee flexion is limited to fifteen degrees beyond a right angle at the end of one year. As a further illustration of the general efficacy of this operation, the two cases presenting well marked hyperextension may be mentioned. This distortion, ordinarily difficult to relieve by operative measures, was completely controlled in both cases.

In conclusion, it may be said that the anterior crucial ligament

plays a vital rôle in the type of knee-joint instability here described. The operation for the reconstruction of that structure is apparently accompanied by no more risk than obtains in the average operation upon the knee joint. The results of the operation are sufficiently encouraging to warrant the statement that any patient of suitable age, with a grossly unstable knee joint of traumatic origin, and without too pronounced secondary changes in the joint, can be given a reasonable assurance of relief from his disability.

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## FRACTURES OF THE HUMERAL CONDYLES IN CHILDREN \*

BY J. S. SPEED, M.D., AND H. B. MACEY, M.D., MEMPHIS, TENNESSEE

Some very interesting facts have been brought out by a study of the results obtained in the treatment of a series of approximately 120 fractures of the humeral condyles in childhood which occurred before the ossification of the epiphyses at the lower end of the humerus. The cases were seen either at the time of the acute fracture, or in later life because of complications which impaired the use of the arm.

The type of fractures included are only those of the internal and external condyles, the detached fragment carrying with it the trochlear or capitellar portion of the articulation. Avulsions of the internal epicondyle are also included, as the problems involved in their treatment are essentially the same. They are to be clearly differentiated from the usual supracondylar fractures, so common in children, which offer an entirely different problem, both as regards the treatment and the results obtained. This distinction between condylar fractures and supracondylar fractures of the humerus is just as vital for a true understanding of the problems involved in their treatment as that between central fractures of the neck of the femur and trochanteric fractures.

If a supracondylar fracture is reasonably well reduced, union takes place with very little, if any, limitation of function in the joint or disturbance in the future growth of the epiphyses.

Experience has shown us that such is not the outlook for condylar fractures. Non-union or malunion of the detached fragment is almost universal with the ordinary closed reduction. This is followed by a sequence of complications. Increasing deformity and distortion of the elbow joint occurs, due to the failure of the affected condyle to develop because of delayed or arrested epiphyseal growth. The result is a cubitus valgus or varus deformity and an unstable joint which often becomes painful after use and in later years is frequently associated with a delayed ulnar palsy. Limitation of motion is the rule in the early years following the fracture and may persist, although many cases develop a full range of motion.

If these complications are to be avoided, immediate accurate reduction of the fracture with close coaptation of the fractured surfaces must be accomplished; otherwise the nutrition of the fragment is impaired and distortion of the epiphysis is unavoidable.

There are certain factors connected with condylar fractures which necessitate a clear view of the fragments to insure a proper reduction, and some dependable type of internal fixation to maintain this position once it has been secured. These factors are as follows:

\* Read at the Annual Meeting of the American Orthopaedic Association, Washington, D. C., May 11, 1933.

Attached to the internal condyles and external condyles respectively are the strong flexor and extensor group of forearm muscles. When either condyle loses its bony anchorage the pull of these muscles displaces it, often turning the condyle end over end and rotating it, if the fracturing force is strong enough to carry the forearm into extreme abduction or adduction. In such cases it is impossible to replace the fragment in its proper position by any type of closed manipulation. Success depends upon a clear view of the entire articular surface of the humerus and free access to the fragment, which must be turned and manoeuvred about, and fitted back into its proper position like the pieces of a jig-saw puzzle. The pull of the attached muscles often makes this difficult even under direct vision. When the reduction is obtained, its insecurity and the ease with which the fragment is displaced can be demonstrated by putting the attached muscles under tension by slight movement of the forearm. The least pull displaces the fragment. A study of the subsequent results in these fractures has shown that even minor displacements of the condyles are incompatible with satisfactory function,—malunion, non-union, and growth disturbances impairing the future use of the joint. It is necessary, then, to use some type of dependable internal fixation which will not allow the fragment to slip and which will hold the fractured surfaces in close apposition if proper union is to be obtained.

We have tried many types of internal fixation, including absorbable sutures, steel wire, bone screws, etc., but have found that the simplest and most reliable is the ordinary wire nail. It fulfills all the requirements for fixation, is easily inserted, apparently does not materially damage the epiphyseal area, and can be easily removed with local anaesthesia at the end of a few weeks when union is solid enough to maintain position.

It is necessary in many cases to drive the nail through the epiphyseal growth line. In such cases the theoretical objection cannot be denied that it is undesirable to leave a foreign body through the epiphysis for so long a time. Practically, however, no irregularity in growth or premature ossification of the epiphysis has been observed following the use of the nail. Certainly, as far as the future fate of the epiphysis is concerned, the advantages attained by prompt and accurate union of the condyle greatly outweigh any damage that the nail may do.

In order to insure a better understanding of the problems involved in treating these fractures, it will be helpful to give a brief description of the muscular attachments to the humeral condyles and a résumé of the ages at which ossification of the various epiphyses takes place.

The lateral epicondyle appears at the thirteenth year, and fuses at the sixteenth or seventeenth year. It gives attachment to the radial collateral ligament and to the tendon of the common origin of the supinator longus and to the following extensor muscles:

1. Extensor carpi radialis longus.
2. Extensor carpi radialis brevis.
3. Extensor communis digitorum.

4. Extensor digiti quinti proprius, which arises with the extensor communis digitorum.
5. Extensor carpi ulnaris.

The capitellum appears at the end of the second year, extends medialward to form the chief part of the articular end of the bone, and fuses at the sixteenth year.

The anconeus arises from the back part of the epicondyle and condyle.

The medial epicondyle appears at the fifth year and fuses at the eighteenth year. It gives attachment to the ulnar collateral ligament, pronator teres, and to a common tendon of origin of the following flexor muscles:

1. Flexor carpi radialis.
2. Palmaris longus.
3. Flexor sublimis digitorum (humeral head).
4. Flexor pollicis longus (may arise from medial epicondyle).
5. Flexor carpi ulnaris (humeral head).

The center for the medial part of the trochlea appears about the twelfth year and fuses at the sixteenth year.

For convenience of description and study, the fractures have been grouped into the following classes:

1. Incomplete fractures of the internal and external condyles without displacement.
2. Fractures of the condyles with displacement, treated by closed reduction.
3. Reconstruction operations for the relief of disability following old fracture.
4. Fractures of the condyles with displacement, treated by delayed open reduction (after three weeks).
5. Acute fractures of the condyles with displacement, treated by immediate open reduction and internal fixation.
6. Avulsions of the internal epicondyle:
  - a. Treated by closed reduction.
  - b. Treated by open reduction and internal fixation.
  - c. Late cases treated by removal, ulnar nerve transplantation, etc.

#### INCOMPLETE FRACTURES OF THE CONDYLES WITHOUT DISPLACEMENT— NINETEEN CASES

This group was included for study because it was thought that these cases might help in determining the true cause of the various complications so common in complete fractures with displacement. The patients were followed and checked by roentgenograms for a sufficiently long period of time to warrant the belief that a perfect functional result was to be anticipated. We have recently been fortunate in getting a number of the patients back for a check-up after periods of from two to twelve years. All of them have shown perfect anatomical and functional results and in

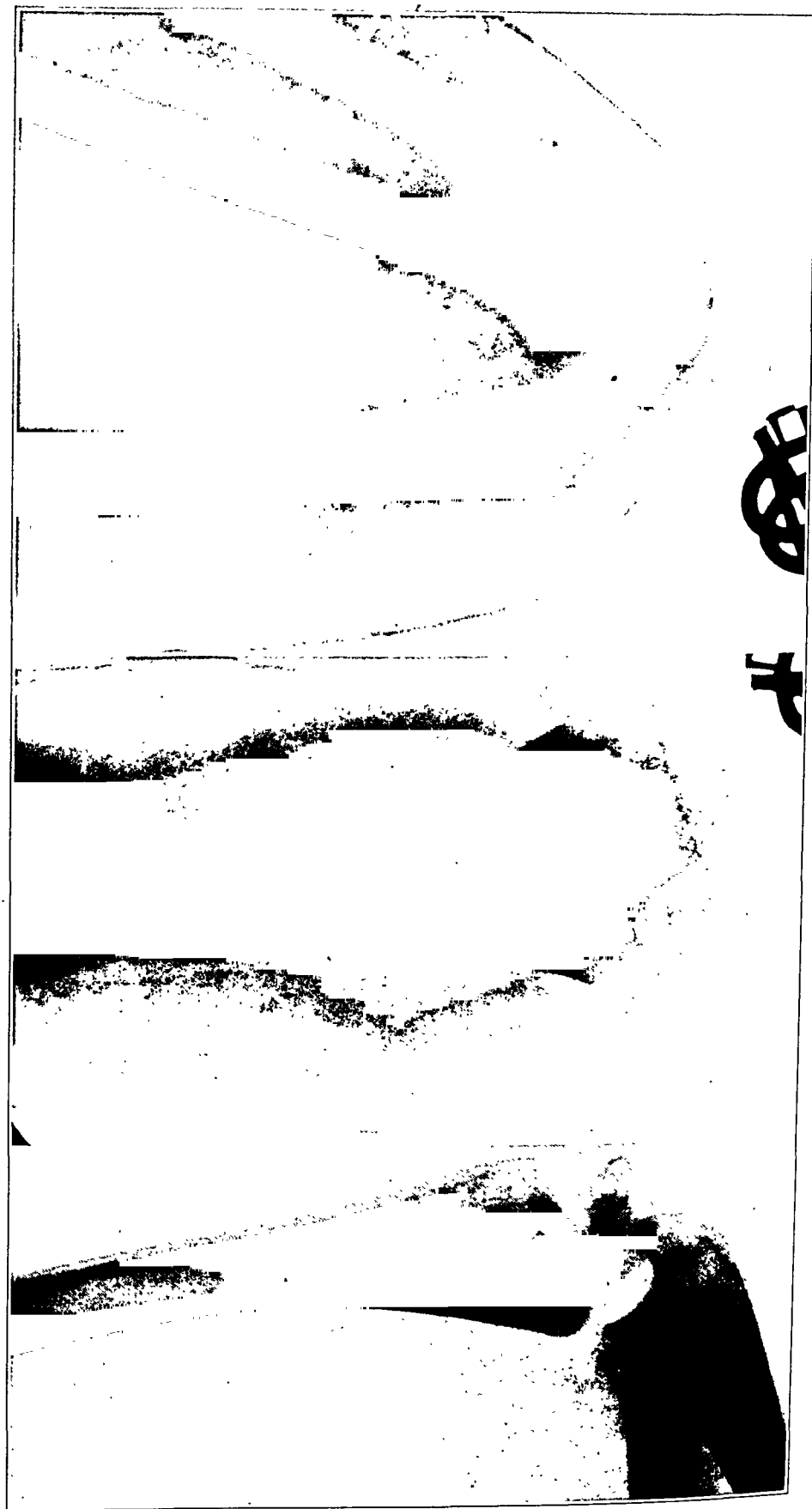


FIG. 1

Case 1. Fracture of the external condyle with moderate displacement. Treated by closed reduction. Relatively good position.



FIG. 2

Case 1. Ten months later. Non-union with epiphyseal changes. Poor functional result. Illustrates uncertainty of closed reduction.

no case have late roentgenograms shown any irregularity in epiphyseal growth or premature ossification of the epiphyses. It is to be concluded then that it is not the dissolution of bony continuity that produces the epiphyseal changes seen in the types of fractures with displacement of the fragments. Further reasoning would indicate that, if we were able to replace accurately the displaced fragments immediately after the injury, we could expect to obtain very much the same satisfactory results.

#### COMPLETE FRACTURES OF THE CONDYLES WITH DISPLACEMENT, TREATED BY CLOSED REDUCTION—FIFTY-NINE CASES

This group, by far the largest, includes all of our own acute cases treated by closed reduction, and all those cases treated in the acute stage elsewhere and coming to us later because of unsatisfactory results.

It has been aptly said that we learn most by our own mistakes and the poor results of others. If so, this group should be a storehouse of information. It is true, of course, that we do not know how many good results may be obtained elsewhere by the closed method, for we naturally never see them, but it is certain that there must be something wrong with a method that produces so many bad results.

Our own experience with the closed method in acute cases leads us to believe that the percentage of good results is relatively low, and that those cases that come out satisfactorily are more the result of good fortune than good management.





FIG. 3

Case 2. Delayed open reduction of external condyle, three weeks after fracture. Fixation with wire nail.



FIG. 4

Case 2. Two and one-half years later, showing bony union, but with epiphyseal changes and some distortion of the capitellum.

The conclusions from a study of the acute group may be summarized as follows: Cases where the detached condyle is only moderately displaced and not rotated can frequently be reduced satisfactorily and a good result obtained. However, subsequent displacements of greater or lesser extent are liable to occur; if so, we are all human enough to accept it, hoping that the result will not be so very bad. Even if we have the courage to advise open reduction after ten days or two weeks, valuable time has been lost. If there is wide separation of the fragments accompanied by rotation or tumbling end over end, closed reduction is extremely difficult or impossible, and the average case will be reduced with inexcusable displacement and irreparable damage to the elbow joint. Of course, the competent surgeon will not accept such a result, and when he finds the closed reduction unsuccessful will do an open reduction then or a few days later, but he should be aware at the beginning of the difficulties of reduction and the probability of subsequent displacement with the closed method and not waste time attempting it. Exceptions prove the rule. There were a few such fractures in this series that were reduced and good results obtained without open reduction, but this procedure is certainly not to be advocated.

The next group are those cases which come in late, several weeks or months after the injury, with only a moderate displacement. In these it is questionable whether a better result will be obtained by leaving them alone or by doing a delayed reduction. Subsequently it will be shown that delayed open reductions are far from satisfactory; union in good posi-



FIG. 5

Case 3. Acute fracture of the external condyle, treated by open reduction. Internal fixation with wire nail.

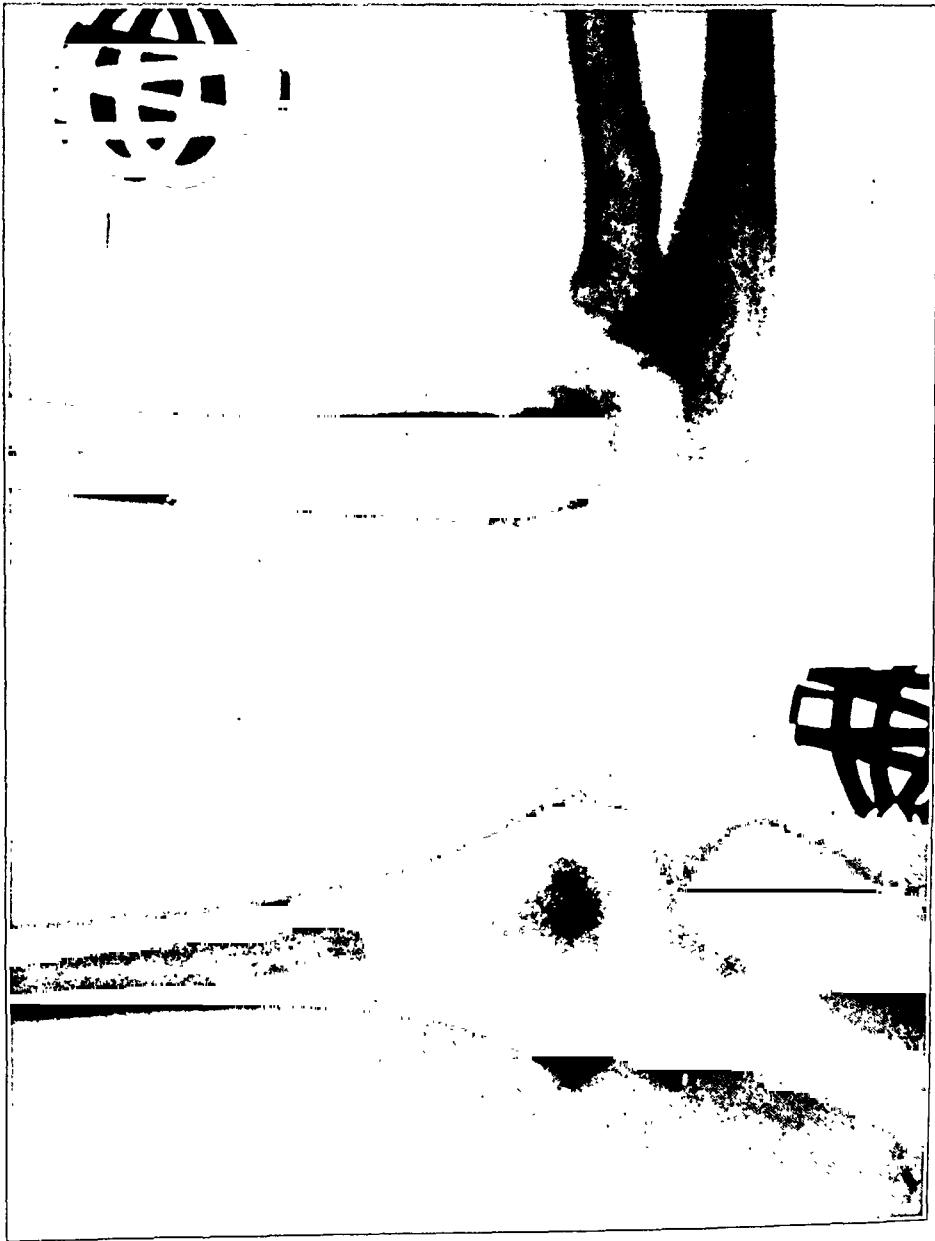


FIG. 6

Case 3. Three weeks later, showing perfect reduction.



FIG. 7

Case 3. Two years later, showing slight irregularity in external condyle, but normal growth. No epiphyseal disturbance; excellent function.

tion can be secured, but subsequent epiphyseal changes are common. If the fragment is united in reasonably good position it is probably better to leave it; if it is not united, or if it is in malposition, the result can be improved by open reduction.

The group which is by far the largest includes all those cases in which the patients come in years after the fracture, seeking relief for disabilities and deformities which have resulted from unsuccessful closed reductions. They consist of non-unions and malunions of either condyle, often with extreme deformity. While many of the elbows are relatively satisfactory for light use, any unusual exertion or trivial injury produces pain and tenderness about the joint. This is easily understood from a study of the roentgenograms which show distortion of the joint, condyles displaced with fibrous union, or complete non-union with marked retardation of growth on the affected side of the humerus. Motion is usually very much restricted in the early years following the fracture and this may persist into adult life, particularly when malunion has resulted. In many other fractures, however, the range of motion gradually increases until in adult life it may equal that of the normal joint. It is surprising sometimes to see joints which, in the roentgenogram, look hopelessly distorted, moving painlessly through practically the normal range of motion.

Many patients with extreme cubitus valgus deformities and ununited or malunited external condyles, who came in for the relief of a delayed ulnar neuritis, were so well satisfied with the use of the elbow that no treatment of the bony deformity was sought or considered advisable.

#### RECONSTRUCTION OPERATIONS

In those cases, however, where there was persistent pain and instability of the joint or where motion was seriously impaired, some type of reconstruction operation was necessary. The indications for such operations were as follows:

1. Deformity.
2. Continuous pain or recurrent attacks of pain following unusual exertion.
3. Instability, rarely seen.
4. Limitation of motion.
5. Delayed ulnar neuritis.

A simple wedge-shaped supracondylar osteotomy is sufficient to correct the deformity in certain cases where the fractured condyle has united in good position with satisfactory motion, but where an inequality in the growth of the condyles has resulted from an epiphyseal disturbance.

Complete removal of a detached external condyle in an adult, where the rest of the joint was normal, has given good results in several cases, but should be combined with a transplantation of the ulnar nerve at the same time, because there is usually already present a cubitus valgus deformity which may increase after the operation. Removal of the condyle should never be performed in children or in adults without careful consideration of what the future effect on the joint would be. It has the advantage of simplicity and is useful in certain cases, but in most instances a reconstruction operation for the purpose of preserving and reuniting the condyle is the rational procedure. When the external condyle is detached in childhood it continues to grow and, if contact is maintained with the head of the radius, a good articulation is developed. In such cases the stability of the joint may depend in a large measure upon the external condyle, and it must be preserved. This can be done and the valgus deformity partially corrected by freshening the old fractured surfaces on the condyle and the humerus and restoring the fragment to as nearly its normal position as possible. It is held in position by an autogenous bone nail, or other type of internal fixation, and union is assisted by an osteoperiosteal graft laid along the posterior lateral side. If the fragment cannot be brought down sufficiently to correct the valgus deformity, it can be united at the most advantageous position and an osteotomy done above the internal condyle to restore the alignment of the joint. Several operations of the type described were done with excellent functional results.

Arthroplasty is indicated as a reconstructive measure when there is serious impairment of motion, or where there is so much distortion or damage to the joint as a whole that it is reasonable to anticipate a per-



FIG. 8

Case 4. Late result in fracture of external condyle treated by closed reduction; non-union with deformity of joint. Such results are preventable by immediate open reduction.

sistence of pain or a recurrence of limited motion if other types of reconstruction work are done. Arthroplasties are contraindicated in children or in cases where the detached fragment extends so high on the humerus that sufficient breadth of surface to secure a stable joint cannot be preserved in remodeling the lower end of the humerus. The results from arthroplasty in properly selected cases are most gratifying.

#### TRANSPLANTATION OF THE ULNAR NERVE FOR DELAYED ULNAR NEURITIS

Delayed ulnar neuritis, or palsy, is a rather frequent complication following the fractures of the humeral condyles occurring in twelve cases of this series. It is usually associated with a cubitus valgus deformity, the increased angle causing a stretching and gradual traumatism of the nerve when the elbow is flexed. It may also be associated with fractures of the internal condyle or internal epicondyle, a fact not generally recognized, but clearly demonstrated by several very interesting cases in this group. Reports of similar cases have recently been made by Copeland.

In one case, a fracture of the internal epicondyle with non-union, the ulnar nerve was unduly lax and slipped over the displaced epicondyle with a snap when the elbow was flexed. In another, a fracture of the

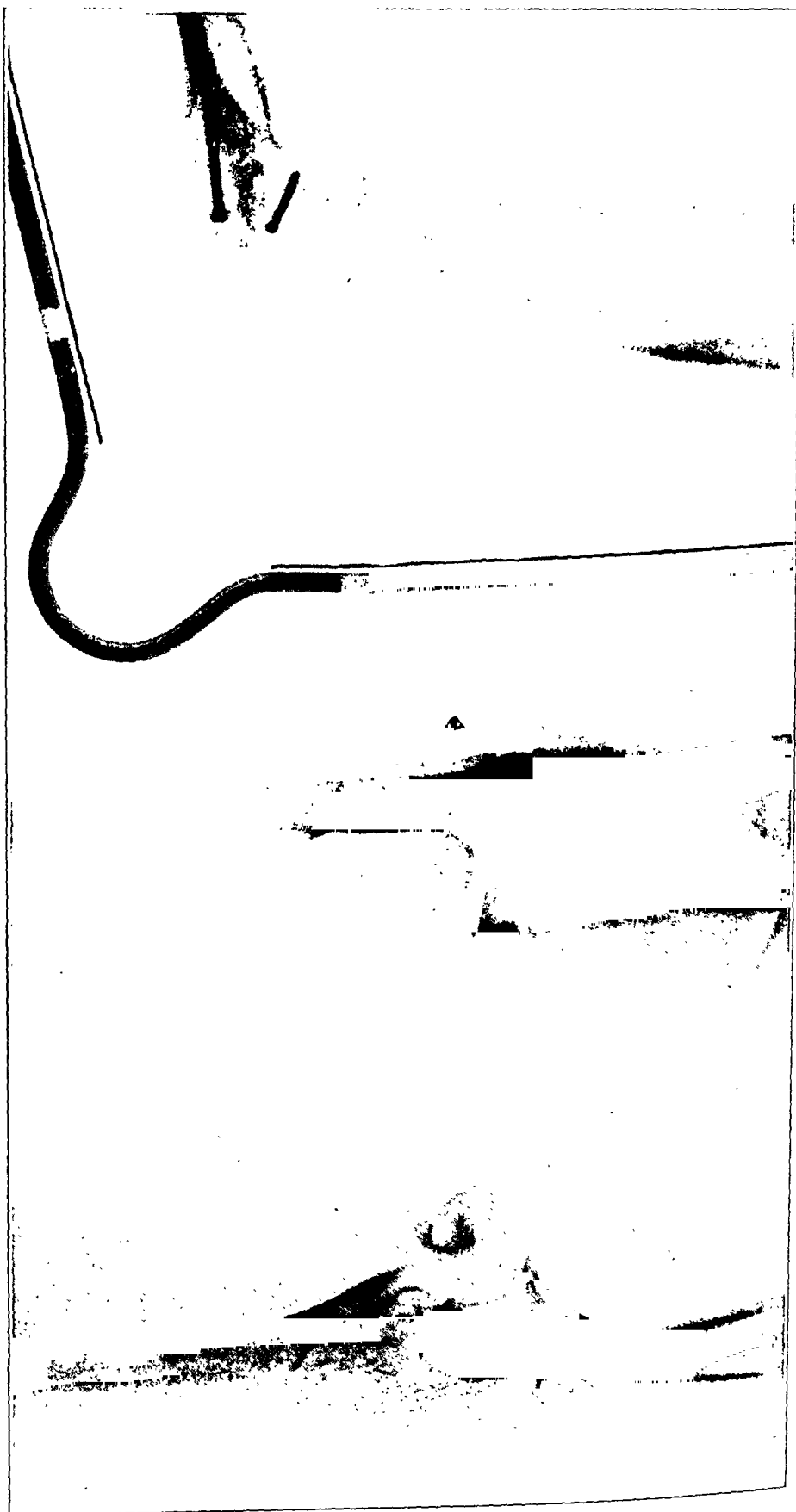


Fig. 9

Case 5. Fracture of the internal condyle with displacement and rotation of fragments. Internal fixation with wire nail.



FIG. 10

Case 5. Six years after operation, showing solid union. Normal function.

internal condyle, the space between the olecranon and internal epicondyle was narrowed and the nerve pinched when the elbow was extended. A third case was due to partial incorporation of the ulnar nerve in callus formation. The symptoms in another case started twenty-five years after a fracture of the internal condyle. At operation the size and course of the ulnar groove were found to be normal, but the nerve was fixed in the groove by adhesions to its sheath which prevented the normal glide of the nerve when the elbow was flexed. This was sufficient to produce a typical neuritis.

In all cases where symptoms were present the usual anterior transplantation was done. In several cases with a cubitus deformity not corrected by the reconstruction operation, transplantation was performed as a preventive measure.

#### COMPLETE FRACTURES OF THE CONDYLES WITH DISPLACEMENT TREATED BY DELAYED OPEN REDUCTION

Contrary to original expectations, the results in this group have been somewhat disappointing. It was hoped that accurate reposition of the displaced condyle, even as long as several months after the fracture, would be followed by firm union without serious epiphyseal disturbance. Haas and others have reported some most interesting results from their experimental work in transplantation of the epiphyses in growing animals. Practically without exception, when a portion of a joint containing an epiphyseal area was completely detached and transplanted to a similar



location in the opposite leg, although bony union occurred, arrest of epiphyseal growth resulted.

On the other hand, roentgenographic studies of the epiphyses in condylar fractures, treated by the closed method, showed continued growth for years, even in those condyles with complete non-union. The condyle did not grow to its normal size or shape, but it was thought that this might be due largely to decreased functional demands. With these facts in mind, it was felt that union in good position, with increased functional demands secured by a careful, delayed, open reduction, would minimize or prevent epiphyseal disturbance. Certain technical difficulties were encountered at operation which probably account in a large measure for the disappointing results.

In order to expose and mobilize the detached fragment sufficiently to derotate it, or to manoeuvre it back to its original position, practically all of the soft tissue attachments had to be severed. In some cases the fragment was unavoidably detached completely. Efforts to avoid disturbance of the blood supply by decreased exposure and mobilization resulted in poor reduction and insecure fixation, which were equally bad. Epiphyseal disturbance was to be expected in those condyles completely detached at operation, but it was disappointing to observe similar changes when a relatively large amount of the muscular attachment was preserved.

Delayed open reductions were done in six cases, in three of which the fragment was completely detached. A study of the results showed that firm bony union in good anatomical position was achieved in all cases where sufficient exposure was obtained and a wire nail used for internal fixation. When insufficiently exposed, or fixed by some type of suture, union occurred with some displacement. In all cases subsequent roentgenograms taken two to four years after operation showed definite distortion of epiphyseal growth, consisting of decreased and irregular growth of the condyle, premature ossification of the epiphysis with varying degrees of varus or valgus deformity. Limitation of motion persisted for long periods of time; in some cases an appreciable amount was permanent.

#### ACUTE FRACTURES OF THE CONDYLES TREATED BY IMMEDIATE OPEN REDUCTION

There were twelve cases in this group and, while not all were without complications, the results as a whole were by far the best. The operation is relatively simple, as the detached condyle is freely movable and with a little manoeuvring can be fitted back accurately into its original position without dividing any of the muscular attachments. When possible the nail is not driven through the epiphyseal line, but we do not hesitate to do so when necessary. The detached fragment was always found to be much larger and to have carried with it much more of the articular surface than the roentgenographic appearance led one to anticipate. This was due to the fact that a large portion of the condyle was composed of cartilage which did not show in the roentgenogram. In many instances the

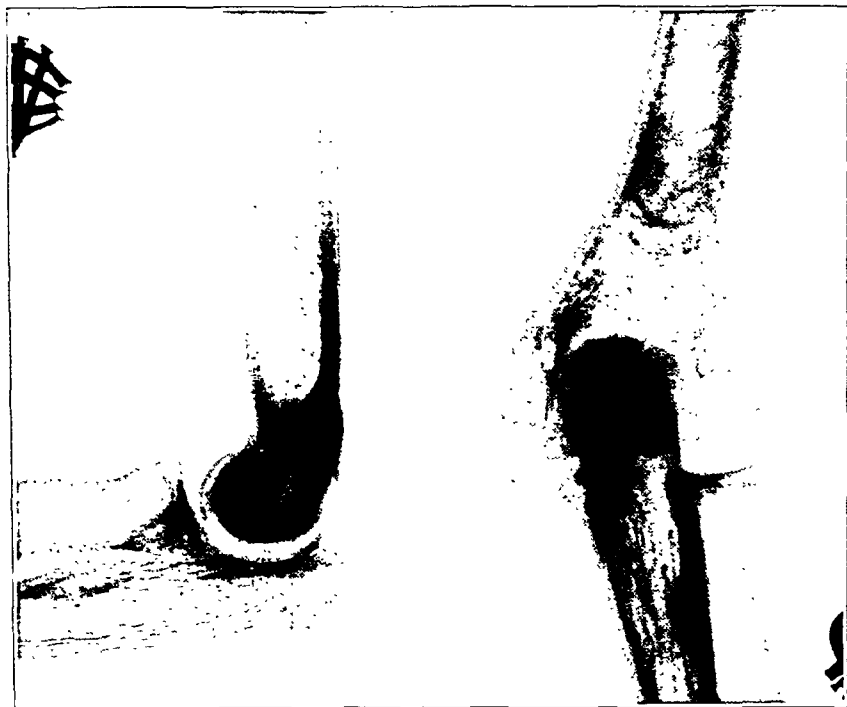


FIG. 11

Case 6. Avulsion of the internal epicondyle five years after treatment by closed reduction. Non-union, with delayed ulnar neuritis.

fragment was completely rotated or turned end over end by the pull of the attached muscle. The futility of attempts at closed reduction was clearly demonstrable in these cases.

Various types of internal fixation—including catgut, steel wire, and nails—were tried. The only one found to be reliable was the nail, which was easy to insert, gave firm dependable fixation, and closely approximated the fractured surface. The head of the nail is left slightly protruding so that it can easily be palpated under the skin and removed after three weeks with a local anaesthetic.

In six of the cases in which the nail was used, excellent functional and anatomical results were obtained. In four cases we have been able to secure roentgenograms from two to six years after the reduction, and they have not shown any retardation or distortion in the growth of the condyle or other evidence of epiphyseal disturbance. Two other patients appeared normal during the period of roentgenographic observation—four and six months—and subsequent reports from their parents state that the arm in each case is normal in appearance and use. One patient at the end of four months shows probable epiphyseal changes and two others are too recent to report.

While it is not contended that occasional excellent results may not

be obtained by closed reduction in displaced condylar fractures, it is claimed that the method is at best uncertain as regards both the original reduction and the subsequent maintenance of position. In view of the serious disturbance in the future function of the elbow joint, resulting from failure at closed reduction or from delayed open reduction, it is felt that, when confronted with the decision as to the method of treatment in an acute condylar fracture, we are not justified in taking such chances. An immediate open reduction should be advised in all cases where there is any appreciable displacement of the fragment.

#### AVULSION OF THE INTERNAL EPICONDYLE

Avulsion of the internal epicondyle is in reality an epiphyseal separation. It is included in this study because it is so closely associated with condylar fractures and because the factors connected with its treatment are so similar. Attached to the internal epicondyle is the strong tendinous origin of the flexor group of muscles. The epiphyseal line between the epicondyle and the internal condyle does not close until about the sixteenth year. When strong lateral strain is put upon the elbow the internal epicondyle may be avulsed either separately or associated with a fracture of the internal condyle. Here again the strong pull of the attached muscles prevents reduction or retention of the fragment by closed reduction. In order to obtain union and prevent arrest of growth of the epicondyle the separated epiphyseal surfaces must be kept in close coaptation and held until union occurs.

There were ten acute cases and six old separations studied. Of the acute cases only four were treated by open reduction, and these were the only ones that united properly. The other six were cases of either non-union or malunion. In three of the acute cases the detached epicondyle was drawn into the elbow joint, locking its motion and requiring open reduction.

Complications were frequent with the unreduced cases. Limitation of extension was frequently seen. This is caused by a blocking of the olecranon which fits in closely against the internal epicondyle when the elbow is extended. Pain after use and bony tenderness about the epicondyle persist in some cases indefinitely. Delayed ulnar neuritis necessitated transplantation of the ulnar nerve in several instances. When limitation of motion, pain, or delayed ulnar neuritis produced disability, the detached or malunited epicondyle and any excess new bone formation were removed, the ulnar nerve usually being transplanted at the same time.

#### SUMMARY

A review of the data brought out in the study of this series of condylar fractures warrants the following conclusions:

1. Serious disability and disturbance of function in the elbow following fractures of the condyles of the humerus in children is much more frequent than is appreciated by the average surgeon treating fractures.

2. Closed reductions are at best uncertain and are frequently impossible when there is displacement of the fragment.

3. Accurate reduction and the maintenance of close apposition of the fractured surfaces are necessary to prevent non-union or malunion, with subsequent epiphyseal disturbances resulting in deformity and impairment of function.

4. Delayed open reductions restore the position of the fragments and achieve bony union, but are almost uniformly followed by epiphyseal disturbance, producing permanent impairment of function.

5. Immediate open reduction, using some type of dependable internal fixation, preferably a wire nail, is the treatment of choice and will give the highest percentage of satisfactory results.

## BLOCK OSTEOTOMY OF THE FEMUR \*

BY EDWIN W. RYERSON, M.D., CHICAGO, ILLINOIS

Abnormal curvature of the femur, due to fracture, rickets, or other causes, usually requires operation for its correction. A transverse osteotomy, while easy to perform, is decidedly not easy in its after-care. The maintenance of proper alignment and apposition requires constant attention and considerable surgical ability. Cuneiform osteotomy, the removal of a wedge of bone, affords greater stability, but a distinct loss of length. A curved osteotomy is mechanically preferable, but is difficult to perform with accuracy.

If, however, a rhomboidal section of the femur can be removed, with its longer side toward the convexity of the curve, and then be transposed by rotating it 180 degrees around its axis, the curvature will not only be corrected, but an actual lengthening of the femur will also be produced. This operation has not received much attention by American surgeons, and the technique of securing the bone block in position has not been standardized. The only article on the subject which the writer has been able to find in recent American literature was published by S. Orell, of Styrso, Sweden (*The Journal of Bone and Joint Surgery*, XIV, 643, July 1932), under the title of "Osteoplastic Cuneiform Osteotomy in the Treatment of Ankylosis". This name, originated by Orell, is rather cumbersome, although it is descriptive. As a substitute, the writer advocates the term "Block Osteotomy". Orell appends a bibliography of thirty-four references, most of which, on examination, deal with other forms of osteotomy. His paper is based upon the report of two cases, where a block osteotomy was performed in 1930,—one in the tibia and one in the femur. In both cases a narrow wedge of bone was removed, boiled for ten minutes in normal salt solution, reversed in position, and secured by catgut sutures. The results were excellent.

The operation is of such great value, in its rather limited field, that it seems worth while to describe again what is apparently a useful method of securing stability and alignment.

### CASE REPORT

In 1922 the author examined a girl nineteen years of age who, in early life, had suffered four fractures of the right femur, resulting in very considerable outward bowing. The left femur had been broken twice, but was comparatively straight, and was about one and one-half inches longer than the right femur. The last fracture had occurred in 1916, when the patient was thirteen years old. Dr. Gibney had operated on the right femur when she was eight. No details of the operation were available.

The patient was short and plump, and, while not distinctly of the Fröhlich type, was considered to have had some endocrine disturbance resulting in osteogenesis imperfecta, or fragilitas ossium.

\* Read before the American Orthopaedic Association at Washington, D. C., May 10, 1933.

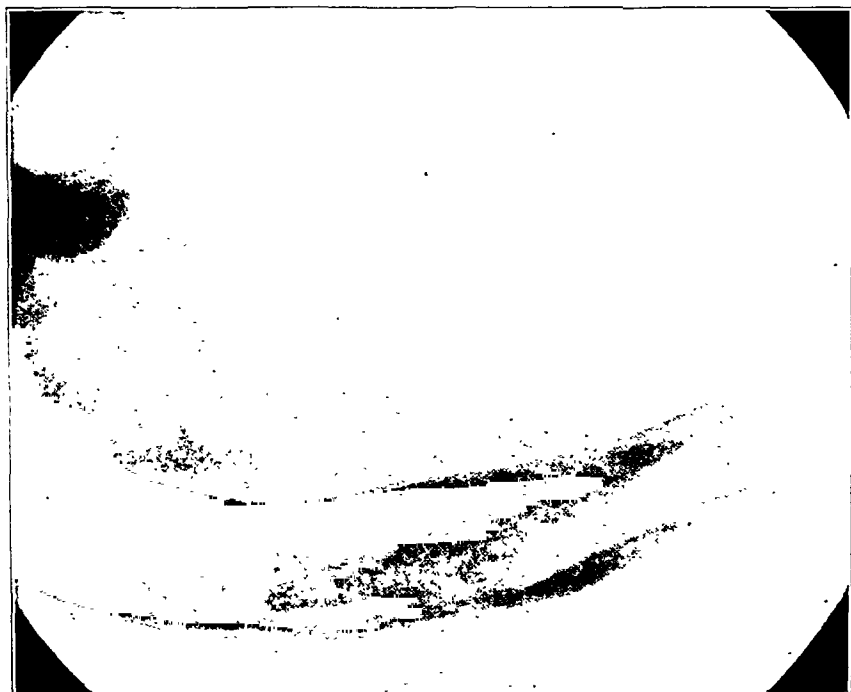


FIG. 2

Showing two healed fractures in shaft. Note density and thickness of cortex.



FIG. 1

Bowed femur, due to fractures in shaft. Note also old fracture through neck.

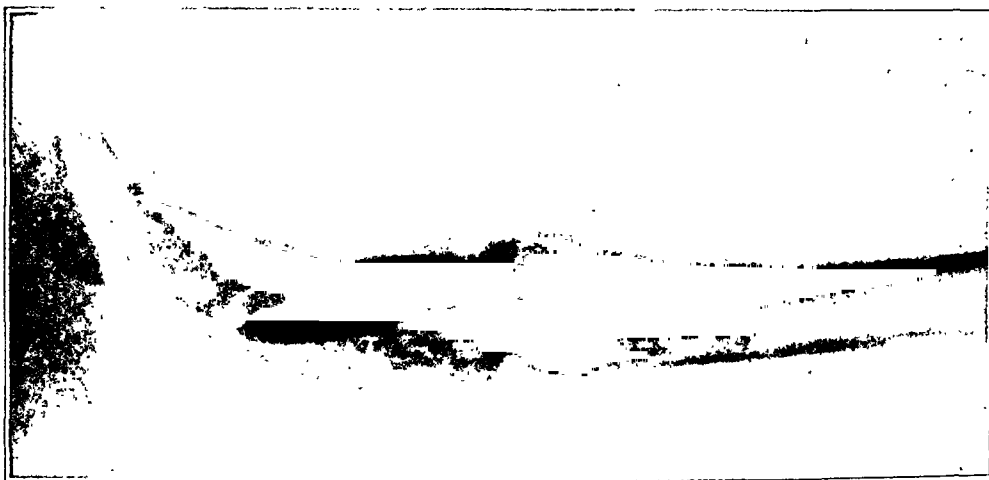


FIG. 5

Six months after operation. Good union. Good correction.

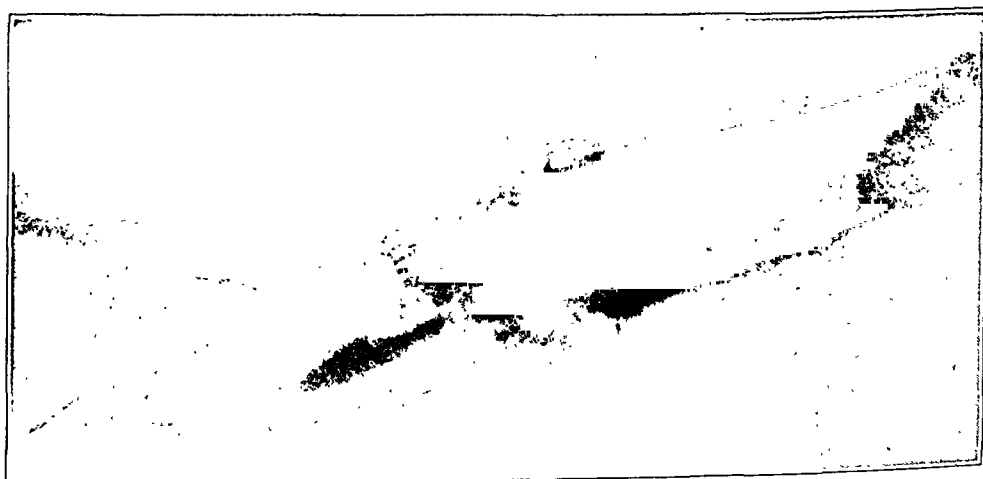


FIG. 4

Four months after operation. Solid union. Partial absorption and fracture of beef-bone peg.



FIG. 3

Three months after operation. Beginning union. Position improved.

The bowing and shortening of the right femur were sufficiently deforming to warrant an attempt to improve the condition; therefore, on September 6, 1922, the following operation was performed:

The shaft of the femur was exposed just above the middle. It was much flattened in section, and was apparently not covered by periosteum. A thick wedge of bone, rhomboidal in outline, was sawed out by two cuts of a Gigli saw. The outer side of the wedge was about one and one-eighth inches in height, and the inner side eleven-sixteenths of an inch. The measurements had been determined beforehand by cutting out a tracing of the x-ray film. This wedge of bone was lifted out and examined. The medullary cavity was much flattened anteroposteriorly, corresponding to the shape of the cortex, and the marrow content was unusually hard. There was very little bleeding from either end of the canal. The wedge was now replaced into the femur, but in reversed position, so that the long side faced medially and the short side faced laterally, thus materially straightening the bowing, and adding considerably to the length of the bone. A beef-bone peg, five inches long and five-sixteenths of an inch in diameter, was inserted into the medullary cavity to hold the wedge-shaped block in position. It was found that the wedge projected too far medially to make an absolutely perfect apposition. This was probably due to the length of the peg, although it was not realized at the time.

The position, however, seemed fairly satisfactory, and the stability was unexpectedly good. After suturing and dressing the wound, a Thomas splint was applied with traction, and the limb was suspended in a Balkan frame. Union was rather slow, but was complete in four months. The correction of the deformity was highly satisfactory, and the only untoward result of the operation was a partial paralysis of the peroneal nerve. This paralysis remained for a considerable time, and only disappeared after a neurolysis performed by Dr. Ober, at which operation no actual lesion of the nerve was discovered.

The x-ray films, taken after the block osteotomy, are interesting because they show an apparent death of the bone-block, followed by a complete regeneration through a process of creeping substitution. The gradual absorption of the beef-bone peg is well shown, and was more rapid in this case than in many others which have been observed.

It will be noted in the x-ray films that the block was cut at a greater angle than was necessary to make a sufficiently satisfactory correction of the bowing. In consequence of this, the cut surfaces were not in perfect apposition. It is probable that union would have occurred in a shorter time if the bones had been in closer contact.

No particular discussion is needed of Orell's proposal to boil the bone-block in normal salt solution. He did this in his first case because the fragment had accidentally become contaminated while being handled. A possible hint as to the reason for boiling the fragment in his second case is his statement that a preliminary preparation of the bone graft for the purpose of removing as completely as possible connective tissue and fat from the bony canals would probably hasten and render more complete the union and reconstruction of the graft.

The author's belief is that many of the bone cells in a bone-graft do not die, and that even a few living bone cells in a graft may be of very great value. Therefore, it does not seem wise to boil a fresh and uncontaminated bone-graft, or to do any more "tinkering" with it than is absolutely necessary.



# THE ASSOCIATION OF PULMONARY AND OTHER TUBERCULOUS LESIONS IN CASES OF PROVEN BONE AND JOINT TUBERCULOSIS

BY C. H. SNYDER, M.D., ANN ARBOR, MICHIGAN

*From the Department of Surgery, University of Michigan*

The variance in the statistics of percentage of cases of bone and joint tuberculosis having coincidental parenchymal lesions may be accounted for by the fact that most of these figures have been taken from cases diagnosed clinically but not proved by laboratory examination. There is also no doubt that many of the so called cures of tuberculous lesions have occurred in cases that were never tuberculous.<sup>5</sup> In seeking to determine what percentage of our cases had lung involvement, we therefore considered only those cases that were proven.

During the past year, 164 consecutive patients clinically diagnosed as tuberculous were observed on the Orthopaedic Service of the University Hospital. One hundred of these were found to have positive pathological reports, or specimens (aspirated material, cultures taken at operation, or smears from sinus tracts) were positive on direct smear, potato-egg culture, or guinea-pig inoculation. Fourteen negative guinea-pig or pathological reports were returned. In fifty cases there were no pathological or bacteriological reports because of the location of the lesion, the severity of the disease, or failure to secure specimen. Other concomitant tuberculous lesions have also been noted, together with the age of onset of the disease. In forty-four cases the tuberculin skin reaction is indicated.

Twenty-seven patients in our series had definite clinical and roentgenographic evidence of parenchymal lesions or adult pulmonary tuberculosis, and thirteen had active childhood tuberculosis. Of forty-one children, aged one to fifteen years inclusive, eight, or 19.5 per cent., had parenchymal lesions and ten were reported to be of the childhood type. The total number having lung involvement in the children's group was 44 per cent. In the fifty-nine patients, sixteen years or over, parenchymal lesions were found in nineteen, or 32 per cent., and childhood tuberculosis in three, giving a total of 37 per cent. Of thirty-seven cases in adults alone, there were fifteen, or 40.5 per cent., who had pulmonary lesions.

If, according to Hecker<sup>3</sup>, we figure the percentage according to the age onset, we find that in sixty cases, or 42 per cent., the onset was before the age of sixteen, with twelve patients having the adult type of tuberculosis and thirteen the childhood type. Of forty patients with the onset after sixteen years, there were sixteen, or 40 per cent., who had parenchymal lesions.

In eight per cent. of our cases the patients were found to have renal

tuberculosis; 6 per cent., tuberculous epididymitis; and 5 per cent., tuberculous tonsils; only 14 per cent. had single tuberculous lesions. Forty-two of forty-four tuberculin skin tests were reported positive.

### HISTORY

The association of other tuberculous lesions with bone and joint tuberculosis has long been recognized, the bone lesion being always secondary. Wiseman and his contemporaries, in the latter part of the seventeenth century, sometimes included under "King's Evil" diseased conditions which were not tuberculous; yet, says Little<sup>1</sup>: "They had evidently a distinct idea of what was meant by the strumous or scrofulous diathesis and associated pulmonary consumption, chronic joint disease, enlarged glands and caries of the vertebrae with one another". Again, in the nineteenth century, we find the French physician, Pierre Louis (1787-1872), giving us the statement since known as Louis' law that "Tuberculosis of any part is attended by tuberculosis in the lungs".

Statistics have been presented from time to time to show how frequently this pulmonary involvement occurs, but most of these cases have been diagnosed only clinically. The figures of Armand-Delille<sup>2</sup>, of 2 per cent. in infants and 5 to 6 per cent. in adults having Potts' disease, vary from those of Hecker<sup>3</sup>, of 63.6 per cent. in children one to three years of age and 5.26 per cent. in patients over sixteen years of age having active lung and skeletal tuberculosis. Hecker states that the percentage will be higher in those in whom the onset occurs earlier in life. MacKinnon<sup>4</sup> in 1924 showed that two-thirds of his patients over sixteen years of age with bone and joint tuberculosis had pulmonary involvement.

In Lehman's<sup>5</sup> series of cases of tuberculosis of bone and joints, in which over 80 per cent. occurred in children under fourteen years of age, 28.2 per cent. of those having Pott's disease had active concomitant tuberculosis elsewhere. Fifty per cent. of the cases of hip joint tuberculosis and 66.66 per cent. of tuberculosis of the knee had other tuberculous lesions.

Keller<sup>10</sup> found only four cases of pulmonary involvement (8.7 per cent.) in forty-six cases of tuberculous osteo-arthritis. Ragolsky<sup>10</sup> in his series of 200 cases of surgical tuberculosis found that one out of six, or 17.5 per cent., had bona fide pulmonary tuberculosis.

"The clinical diagnosis of bone tuberculosis is still to be made with much caution and still to be regarded with suspicion and is to be accepted as an undisputable fact only when it has been checked by pathological section and the demonstration of the tubercle bacilli."<sup>5</sup> Of 822 cases in the files listed as tuberculosis, Milgram says that only 139, or 17 per cent., were proven cases; fifty-four, or 38.8 per cent., were not correctly diagnosed until operation and pathological section gave the diagnosis. Hough<sup>6</sup> reports on the tuberculin skin reaction in a group of seventy-seven clinical cases of bone and joint tuberculosis in which only fifteen, or 19.5 per cent., were proven cases.

Smith<sup>7</sup>, writing on monarticular arthritis, informs us that this lesion

TABLE I  
SUMMARY OF CASES \*†

AGE	SEX	RACE	AGE AT ONSET	TUBERCULIN SKIN TEST**	ADULT PARENCHYMAL TUBERCULOSIS	CHILDHOOD TUBERCULOSIS	TUBERCULOUS LESION	OTHER TUBERCULOUS LESIONS
12	F	Col.	5	P	-	-	Left hip, right knee	
12	F	W	11	P	-	-	Left hip, ilium with sinus	
44	M	W	38	O	-	-	Greater trochanter with abscess	
							Left wrist with tuberculous bursa (died)	
27	M	W	26	O	-	-	Left radius with sinus	
19	M	W	18	P	-	-	Sacro-iliac joint with sinus	
4	F	W	3	P		P	Spine { Tonsils and adenoids Cervical lymph nodes	
14	F	Col.	10	O	-	-	Right hip	
3	M	W	2	P	-	-	Left knee	
26	F	W	23	O	-	-	Right elbow	Adenitis
17	F	W	17	O	P	-	Right first metatarsal, left ankle	
17	M	W	15	O	-	P	Right knee	Tonsils and adenoids
15	M	W	15	O	-	P	Right hip	
5	M	W	3	P	-	P	Left hip with abscess	
24	M	W	24	O	-	-	Left ilium	Multiple sinuses, thigh
20	M	W	19	O	-	-	Right femur with sinus	
2	M	W	2	P	P	-	Right knee	
16	F	W	14	P	-	-	Right knee, manubrium sterni	3 to 7 ribs anterior
48	M	W	46	O	-	-	Spine (died)	Epididymitis. Transvers myelitis. Meningitis
14	F	Col.	13	O	-	-	Right knee with sinus	
28	M	Col.	27	P	-	-	Spine with psoas abscess	
18	M	W	3	O	-	-	Spine	Renal, vas and epididymis
12	M	Ind.	6	P	-	-	Right hip, cervical spine	
45	M	W	43	O	P	-	Spine	Left epididymis
5	M	W	5	P	-	P	Right ischium, cold abscess	
25	M	W	22	O	P	-	Left elbow, right hip	Bilateral renal
26	M	W	25	O	P	-	Spine and sacrum, abscess	
32	F	W	32	-	-	-	Spine with psoas abscess	
8	F	W	4	O	P	-	Left tarsus	
31	M	W	20	O	-	-	Spine	Left renal
28	M	W	24	-	-	-	Spine with sinus	Cervical glands
37	M	W	35	O	P	-	Left acromioclavicular joint with abscess	
8	M	W	6	O	-	P	Right ankle	
25	M	W	17	O	-	-	Spine with sinus	
19	F	W	6	P	-	-	Tenosynovitis	
7	M	W	4	P	-	P	Spine	Tenosynovitis
61	M	W	59	O	P	-	Spine, right elbow with sinus	
26	M	W	24	O	P	-	Hip, greater trochanter right	
22	M	W	13	O	-	-	Hip with sinus	
2	M	W	1½	P	-	P	Right hip	
34	F	W	28	O	P	-	Spine	Bilateral renal, healed laryngeal
23	F	W	21	P	P	-	Right sacro-iliac	Right renal, peritoneum sinus right thumb (met acarpal-phalangeal joint)
27	F	W	26	P	P	-	Right sacro-iliac	
25	F	W	3	O	P	-	Spine, right hip	
6	F	Ind.	5	P	-	-	Hip with sinus, and ilium	
11	M	W	7	P	-	-	Left hip with sinus	Left renal and ureter (Fluid aspirated from chest at age of 13)
25	F	W	17	O	-	-	Dorsal spine	
50	M	Col.	49	O	-	-	Dorsal spine with cold abscess, tuberculous 11-12 ribs	Pleurisy with effusion
53	M	W	52	O	-	-	Left elbow, sinus	
16	F	W	3	P	-	-	Right hip	
10	F	W	9	O	-	-	Spine with abscess	
25	F	W	21	O	P	-	Sacro-iliac joint with sinus	
18	F	W	5	P	-	-	Right hip with abscess, subastragaloid joint	
7	F	W	2	P	-	-	Left knee with sinus	
4	M	W	1½	P	P	-	Left hip with sinus	

TABLE I (Continued)

SUMMARY OF CASES \*†

AGE	SEX	RACE	AGE AT ONSET	TUBERCULIN SKIN TEST**	ADULT PARENCHYMAL TUBERCULOSIS	CHILDHOOD TUBERCULOSIS	TUBERCULOUS LESION	OTHER TUBERCULOUS LESIONS
17	F	W	9	O	-	P	Spine with sinuses (died)	At autopsy, mediastinal lymph nodes, nephritis, cystitis, chronic meningitis, localized pulmonary tuberculosis.
8	M	W	4	O	-		Spine with sinuses	
4	M	W	2	P	-	P	Spine, left ankle	Scrofuloderma, cervical adenitis
29	F	W	10	P	-		Sinus, left hip	
20	M	W	17	P	-		Right hip with sinus	
21	M	Ind.	18	P	P		Spine with abscess	
34	F	W	22	P	P		Spine with abscess	
50	M	W	50	O	-		Elbow with sinus	
10	M	W	8	O	-		Left knee	
12	F	W	10	O	-		Right elbow	
17	F	W	15	P	P		Left hip	
11	F	W	2	O	-		Spine	Tonsils
24	M	Col.	23	O	-		Left elbow	
16	M	W	14	O	-		Left ankle, sinus	
13	F	W	13	P		P	Right ankle	
18	F	W	3	O	-		Right hip	Left kidney
11	F	W	11	O	P		Right hip with sinus (died)	Meningitis
14	F	W	12	P	-		Right hip	
26	M	W	21	O	-		Right hip with sinus	
31	M	W	29	P	-		Right hip	
10	M	W	10	P		P	Right elbow	
17	M	W	16	O	-		Subastragaloid joint with sinus	
13	M	W	12	O	P		Right knee	
38	M	Col.	35	O	-		Spine with abscess	
45	M	W	43	P	P		Wrist, right (died)	Laryngitis, bilateral re-epididymis
20	M	W	15	O	P		Left hip	
18	M	Ind.	11	P	-		Left forefoot	
16	M	W	15	O	-		Right knee	
14	F	W	12	P	P		Both ankles, first metatarsal-phalangeal joint left	
4	F	W	3	P	-		Left hip, abscess	
18	F	W	3	P	-		Spine with sinus	
12	M	W	3	O	-		Bilateral hip, abscess	Cervical adenitis with sinus
3	F	W	1½	P	-		Right subastragaloid joint	
29	F	W	27	O	P		Left shoulder, left elbow	
13	M	W	12	P	P		Left knee	Tonsils
15	M	W	7	O	-		Humerus with sinus	Tonsils
16	M	W	6	O	-		Right hip	Anal fistula, adenoids
15	F	W	7	P	-		Right hip with sinus	
8	F	W	4	O	P		Bilateral wrists, right mid-tarsal joint	
26	M	W	16	O	-		Left hip and ankle	Epididymitis, anal fistula, prostatitis
11	F	W	5	O	-		Left hip	
25	M	W	22	P	P		Spine, right elbow (died)	Left epididymis
8	M	W	3	O	-		Left knee	Skin (ulcus vulgaris)
19	F	W	10	O	-	P	Right knee	Cervical glands
10	M	W	7	P	-		Right hip	
31	M	W	20	O	-		Right shoulder with sinus	

Analysis of Above 100 Cases by Race and Sex:

	Male	Female	Total
White	52	37	89
Colored	4	3	7
Indian	3	1	4
Total	59	41	100

\*\* P = test positive  
 - = test negative  
 O = test not done

may simulate tuberculosis very closely. "It is impossible to differentiate these lesions from those of tuberculosis by physical examination or the x-ray." The majority of these patients will recover without further treatment.

Following this trend of thought, and bearing in mind King's<sup>8</sup> statement, *viz.*: "In order that proper therapeutic measures can be initiated with hope of success and also to properly evaluate benefit derived from treatment, we consider it essential to establish beyond a doubt the nature of the pathological process", we prepared our report based on the study of 100 cases of substantiated bone and joint tuberculosis.

#### RENAL INVOLVEMENT

Harris<sup>11</sup> says, "In a series of 100 patients whom I have examined for this purpose, more than half, on adequate examination, displayed multiple foci of haematogenous origin. . . . But with the arrival of the day when tuberculosis is clearly regarded as a systemic disease will come the time when examination of the urinary tract will be thought as necessary as the examination of the chest." In another contribution<sup>12</sup> he states: "Tuberculosis of the spine and other forms of bone tuberculosis arise by invasion of the bone from the blood stream. . . . In the majority of cases this will be a pulmonary lesion with its concomitant mediastinal adenitis. . . . Renal tuberculosis is particularly prone to accompany bone lesions." In his series of 100 patients having bone and joint tuberculosis, 37 per cent. of the adults had tubercle bacilli in the urine constantly or intermittently, and 13 per cent. of the children had similar positive reactions over a period of one and one-half to five years.

In our series it was definitely established that 8 per cent. had renal tuberculosis, four of the cases having bilateral involvement. However, in view of Harris' work and because we have found renal tuberculosis relatively late in our cases, we believe that more frequent and more careful urinalyses should be made, together with guinea-pig inoculation, in cases of true skeletal tuberculosis. As a matter of routine, we take roentgenograms of the chest of every patient having bone and joint tuberculosis, and make a special stain and guinea-pig inoculation of the urine of those patients having an acid urine, containing no organisms but in which white blood cells and some red blood cells are found by ordinary staining methods.

#### TUBERCULIN SKIN TESTS

In forty-four of our cases the patients were tested by the human tuberculin and when possible the tests were done by the same physician, using the Mantoux method. The tuberculo-protein ultrafiltrate or tuberculo-protein trichloroacetic gave the best results. Only two patients were reported as having negative reactions.

Later twenty-six patients with tuberculous bones and joints—fifteen of whom were proven cases—and two patients with old poliomyelitis,

aged fourteen and sixteen years, were tested by the Mantoux method. With T.P.T. (tuberculo-protein trichloroacetic), one-tenth cubic centimeter of a one to ten thousand dilution was first used and three of the fifteen cases gave positive skin reactions. The one to one hundred dilution was then used and seven cases developed erythema and induration in forty-eight hours, while all were positive in seventy-two hours except the controls which were still negative.

Hough<sup>6</sup> found positive tuberculin skin tests, both bovine and human, in 60 per cent. of his orthopaedic cases of verified tuberculosis, and positive bovine but negative human tests in 33 per cent. Harris<sup>12</sup>, however, states: "The great majority of the cases are of human origin". If we are justified in the assumption that the skin reaction is specific for the type of organism, then we can assume that, at least in our forty-four cases, the majority are of human origin.

#### TUBERCULOUS CONTACT

We believe with Forbes<sup>13</sup> that intimate and prolonged family contact is responsible for massive infection and the production of childhood tuberculosis; 68.4 per cent. of the patients in his series gave a history of family contact with the disease. We were unable to confirm this but, of our twenty-seven cases of parenchymal tuberculosis, the history of contact was as follows: twelve, not known; thirteen, positive; and only two, negative.

#### SUMMARY

Attention is again called to the fact that bone and joint tuberculosis is a systemic disease.

The point is stressed that a positive diagnosis is essential to correct treatment and accurate interpretation of results.

Of 164 consecutive patients, seen during the past year, clinically diagnosed as having bone and joint tuberculosis, 100 were established cases, fifty had no pathological or bacteriological reports, and in fourteen the guinea-pig inoculation and pathological results were negative.

Pulmonary lesions in substantiated bone and joint tuberculosis average 40 per cent. in our series,—27 per cent. with adult pulmonary or parenchymal lesions, and 13 per cent. with active childhood pulmonary tuberculosis. Patients over sixteen years of age averaged 37.3 per cent.: those under sixteen years, 44 per cent.

When the pulmonary lesion is determined from the age of the patient at onset of the bone and joint lesion, those under sixteen years—sixty patients—averaged 42 per cent. and those over sixteen years—forty patients—averaged 40 per cent.

Eight per cent. of our cases had renal tuberculosis.

More frequent urinalyses, guinea-pig inoculation, and special search for tubercle bacilli are urged in the treatment of patients having an acid urine containing no organisms, but in which white and red blood cells are found by the usual staining methods.

A negative tuberculin skin test, especially if negative to repeated increasing dosage of a recently prepared or fresh solution of old tuberculin or tuberculo-protein trichloroacetic, is of definite diagnostic value.

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## A TREATMENT FOR FRACTURE OF THE NECK OF THE FEMUR\*

BY GUY W. LEADBETTER, M.D., WASHINGTON, D. C.

Fractures of the neck of the femur have become a vital issue to the surgeon, the patient, and the relatives of the latter. During the last few years the standard of demand by the laity for better functional results of fractures has been more exacting. It is incumbent upon the physician to select the method which, in his judgment, will cause the least amount of primary shock during manipulation, to utilize the fixation which will adequately maintain reduction, and, finally, to secure a high percentage of anatomical reduction and firm union with good physiological results.

Whatever method of reduction and fixation is selected, the writer believes that the so called after-care is the most important in the preservation of life. Because of age, the functions of the individual are at a basic level and, in most cases, trauma and subsequent shock have caused the vitality to drop to a still lower level. It is essential, therefore, that no treatment be instituted which will further depress the vital centers, for pain in most fractured hips subsequent to reduction is negligible. Good elimination and frequent change of position are important factors. Due attention to the two dangerous complications—general toxicosis, having its origin in the intestinal tract, and pulmonary hypostasis—will also aid in preventing the third serious complication,—that of mental bewilderment, delirium, or psychosis.

Without hesitation the writer recommends plaster fixation, properly applied, as the best means of carrying out all the above mentioned treatment. Plaster fixation must have two objectives: first, to immobilize the fracture; and, second, to facilitate postoperative care. This plaster should be applied tightly and we have found the following technique to be the best.

With the hip reduced and in the proper degree of abduction and internal rotation, a one-layer thickness of glazed cotton is placed about the torso from the nipple line over the affected hip to a point about half-way between the hip and the knee. Then a long strip of felt, one-half an inch thick, is placed about the pelvis, extending from just above the iliac crests to the trochanters, and completely encircling the pelvis. This is all the padding necessary and allows very tight application of plaster. The body portion is first applied as tightly as possible, snug coaptation being the aim. Firm pressure over the injured hip is necessary. Below the hip no padding is applied. Two plaster slabs molded carefully to the contour of the leg, one posteriorly and one anteriorly, are bandaged closely to the skin. No padding is placed beneath the heel, as this is molded well and the plaster coapted tightly. If necessary, one may apply

\* Read before the American Orthopaedic Association at Toronto, Canada, June 16, 1932.



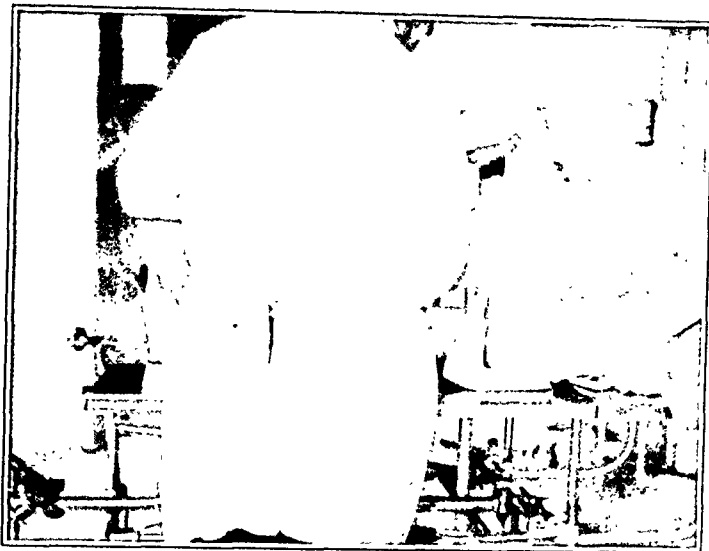


FIG. 1

First manoeuver. Hip flexed to ninety degrees.

swinging the torso, thereby diminishing the amount of abduction of the injured leg.

This method gives firm and comfortable immobilization and allows the treatment previously described to be instituted without danger of changing the position of the reduced fracture. It permits relatively free movement of the thoracic cage, makes a semireclining position possible, and facilitates transportation from bed to chair. In our series of cases, using this type of application, we have had no decubital ulcers. In one or two instances, in which the individual was fairly vigorous, we have been able to allow walking with the aid of crutches after the fourth week.

The procedure for manipulation should be non-shocking and one

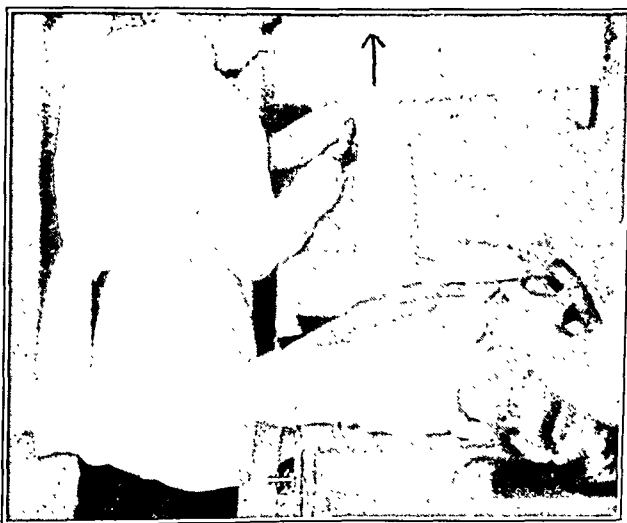


FIG. 2

Second manoeuver. With knee flexed, traction is made in longitudinal axis of femur as indicated by arrow.

a roll of plaster about the two molded splints to insure a little better fixation. The cast is then trimmed around the perineum and the pelvis in the usual manner. The "U" is cut from the body section of the cast, leaving about a six-inch band across the lower abdomen and over the symphysis. The sides must be well supported to prevent the patient from

which accomplishes anatomical reduction of the fractured fragments with the greatest degree of accuracy. Anatomical reposition of the fragments is the only position which insures good union and good function. Up to the present time the Whitman method is the widely accepted one. Dr. Whitman's article written in 1904 clearly shows the genius of his logic. Abduction and internal rotation quite apparently are the only positions for reducing a

traumatic coxa vara. The objections to his manipulation are:

1. It is very often a shocking procedure in the hands of the average practitioner, as well as in some skilled hands, and is done too empirically.
2. It does not consider all the anatomical and physiological factors present in the hip joint, such as muscular attachment and muscular tension.
3. The extreme degree of abduction called for, often overreduces the fragments and produces no reduction, with poor continuity.
4. The forced internal rotation called for serves only to relax the Y ligament at the hip joint and many times results in no reduction and gives no splinting effect whatsoever.
5. There is no definite test or examination other than the roentgen ray, which definitely tells the manipulator that the fracture has been reduced.

To the postoperative care and to the plaster-fixation method the writer can well subscribe.

Treatment by the various traction methods, or by the so called sand-bag method—which is no method at all—is not to be considered.

The manipulation suggested here is simple, anatomically sound, non-shocking, and offers opportunity for 100 per cent. reduction. The patient is first anaesthetized, usually with ethylene gas, on the fracture table. The uninjured leg is harnessed to the foot stirrup.

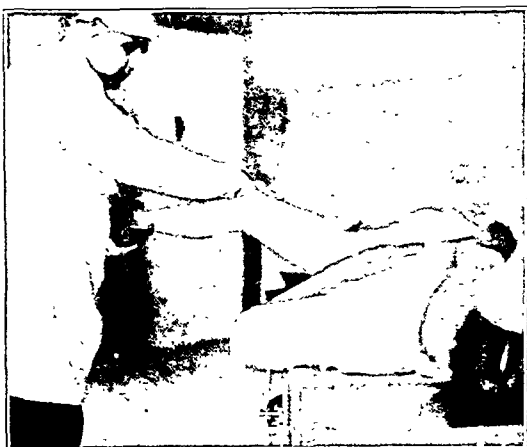


FIG. 3

Third manoeuver. Leg is circumducted into measured degree of abduction and internal rotation.



FIG. 4

Fourth manoeuver. Heel-palm test. With leg in abduction and internal rotation, the heel is allowed to rest in outstretched palm. With complete reduction this position should be maintained without force. If leg rotates externally, reduction is not complete.

The injured leg is then flexed at the hip at ninety degrees, with the lower leg at ninety degrees to the thigh. Direct manual traction in the axis of the flexed thigh is then made, together with slight adduction of the femoral shaft. In this position the thigh is internally rotated approximately forty-five degrees. The leg is slowly circumducted into abduction, the internally rotated position being maintained. The amount of abduction varies with the individual and can be measured accurately, representing the difference in degrees of the angle made by the fractured neck with the shaft and the angle between the neck and the shaft on the normal side, as evidenced by the roentgenogram.

The test which in our experience has indicated that the fracture has been completely reduced is as follows. After the leg has been brought down in the measured degree of abduction and internal rotation, the heel of the injured leg is allowed to rest on the outstretched palm. If the reduction is complete, the leg will not evert itself. Should there be no interlocking of the fragments, however, the leg will slowly rotate externally. This has been found to be an invariable test. In all instances where the test evidenced internal rotation, the reduction was anatomically complete. In cases where the internal rotation had to be forced, the reduction was never complete, as proven by stereoscopic roentgenograms, the only criterion for a good reduction. The observation is made that as



FIG. 5

Case 1. Patient aged seventy-eight. Premanipulative roentgenogram. Note slight degree of coxa vara with considerable external rotation.

the leg is circumducted into a position of abduction and internal rotation without tension, the position of the leg tends to assume the proper degree of abduction and internal rotation. If abducted too far, one will feel the definite tension of the adductors which can be neutralized by allowing the leg to assume a smaller angle of abduction. If internal rotation is too great, the leg, under the heel-palm test, will rotate outward until the proper degree of internal rotation is reached. One can approximate the desired degree of such abduction and rotation by a study of premanipulative roentgenograms, for, at the time of the actual manipulation, the finer degrees will be adjusted automatically by muscle tension of the hip.

The consideration of the embryology and anatomy of the hip joint lays the foundation of the manipulation described. In the embryo, the hip joint is in the quadrupedal position,—namely, it is flexed and only after several weeks of extra-uterine life does the flexed position tend to assume that which is necessary for bipedal ambulation. This change of position accounts for the rotation in the neck of the femur, also for that of the fibers constituting the capsular ligament. It is a physical fact that when the hip is brought back to the quadrupedal position, all structures about the hip joint are relaxed, since the base of the neck of the femur is the



FIG. 6

Case 1. After reduction. Note slight degree of abduction and complete internal rotation.



FIG. 7

Case 1. End result. Bony union.

insertion point of the hip joint muscles; this forms the center of rotation which relaxes these structures in manipulation. One cannot depend upon an extreme grade of abduction or upon the tenseness of the Y ligament, as suggested by Dr. Whitman, since it is not true that these ligamentous fibers are taut in internal rotation. One must depend upon an accurate interlocking of the fragments.

The type of fracture must also be considered, for in fractures of the neck of the femur one sees not only transverse fractures, but also spiral, oblique, and comminuted fractures. It is, therefore, just as difficult to maintain the position in a spiral, or comminuted, fracture of the neck of the femur as in any other bone. The fixation must be equally complete. The transverse type of fracture, as a rule, gives little difficulty in maintenance of position. In general the oblique, or spiral, fracture must be abducted slightly more than the transverse type after reduction. An extreme grade of accuracy in completing the apposition of the fragments is the factor on which rests the possibility of union, for, with the absence of periosteum, the presence of synovial fluid, and the activity of the

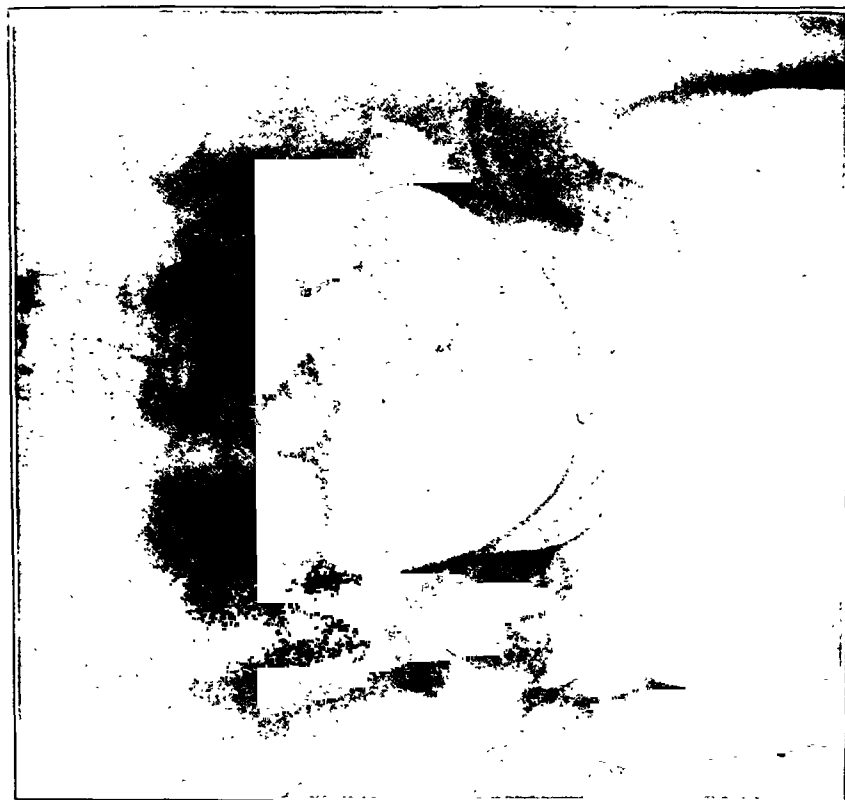


FIG. 8

Case 2. Patient aged sixty-seven. Premanipulative roentgenogram. Coxal vara marked. This case demands more abduction than Case 1.

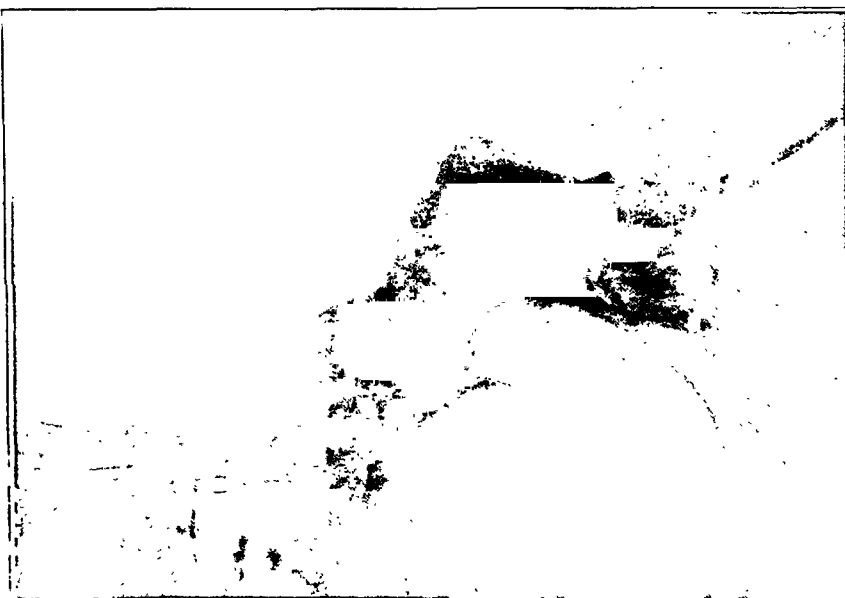


FIG. 9

Case 2. After reduction. Note greater abduction than in Case 1.



FIG. 10

Case 2. End result. Bony union with coxa vara. Good function.

cancellous structure of the neck as the only real source of bone formation, it can readily be seen that, if this cancellous tissue is encroached upon or blocked by an inaccurate reduction, by improper fixation, or by the use of internal metal fixatives, proper bony healing can never take place. Circulation is important only in so far as it is allowed to course through its normal channels which supply nourishment to both ends of the fractured fragments. In reconstruction operations for non-union, the author has been much impressed with the very rapid and strong bridging over of the fractured surface of the head and of the neck in cases in which imperfect apposition had been made. This shows in itself that healing properties are present in the necks of most femora, and that all that is demanded is proper, careful reduction with thorough fixation for a period of not more than ten to twelve weeks.

In this paper is presented a study of thirty-six cases, all treated by the method just described. The five cases of intertrochanteric fracture obtained bony union. The thirty-one cases of intracapsular fracture reported here (Table I) have been checked and rechecked and represent accurate findings. These patients have been interviewed or heard from through their personal physicians. Of these thirty-one cases, a total of twenty-two, or 70.9 per cent., obtained bony union and nine, or 29 per

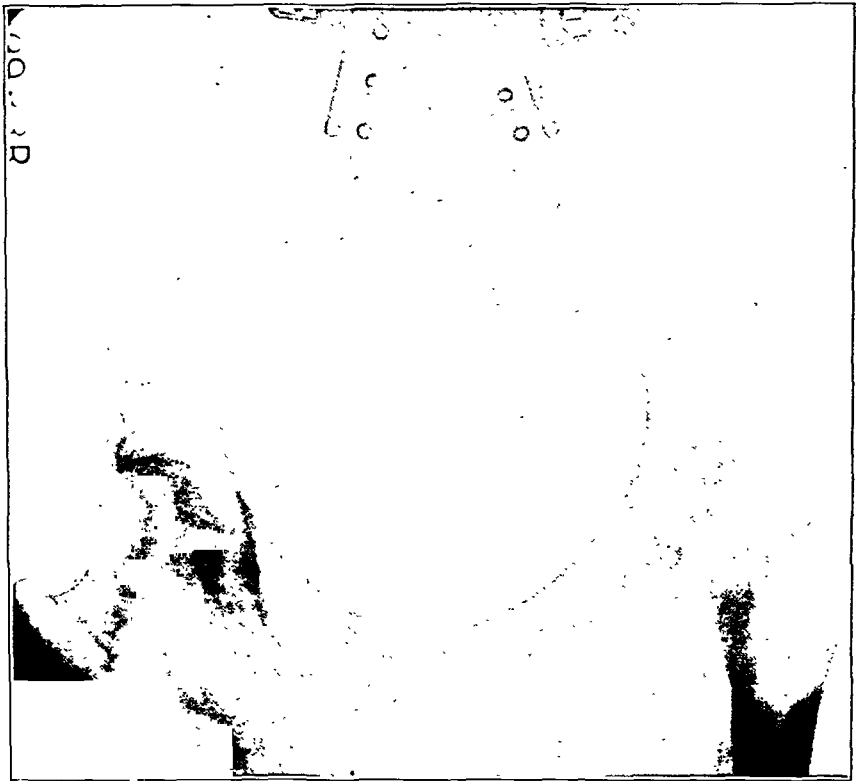


FIG. 11

Case 3. End result. Bony union.

cent., presented fibrous union and are considered in this series as non-union cases. Of the non-union group two, or 6.4 per cent., showed absorption within a period of approximately six weeks. The remaining seven, or

TABLE I  
INTRACAPSULAR FRACTURES OF THE NECK OF THE FEMUR

Age	Cases	Union	Non-Union		Fair Function	Good Function	Deaths
			Fibrous	Absorption			
30-40. . . . .	1	1				1	
40-50. . . . .	3	3				3	
50-60. . . . .	2	2				2	2
60-70. . . . .	14	10	4		4	10	
70-80. . . . .	6	4	1	1	1	4	1
80-90. . . . .	5	2	2	1	2	2	1
Total. . . . .	31	22	7	2	7	22	4



22.5 per cent., obtained fair function. Of the cases showing fracture of the anatomical neck, in which union was obtained, ten, or 32.2 per cent., were patients over sixty years of age, and four, or 12.8 per cent., were over seventy years of age. The remainder were in the decades between forty and sixty years. All of these cases united well. The deaths numbered four, or 12.8 per cent. The first was due to embolism at the tenth week and the second was due to diabetic coma at the twelfth week. Both of these cases belonged in that group in which absorption occurred. The third died of cellulitis of the neck at the twentieth week, and the fourth of acute nephritis at the fourteenth week. With the exception of the first and last named cases, fracture of the neck of the femur was not implicated in the cause of mortality.

This paper, then, presents a method of manipulation which is anatomically and physiologically logical. It is easy to accomplish and, by applying the test which the author believes to be infallible, assures one of good anatomical reduction, thereby greatly enhancing the chances of bony union by preserving the normal relations of the only source of callus in the neck of the femur,—namely, the cancellous structure. As soon as we free ourselves from the didactic and empirical teachings which have been in vogue for the last twenty-five years and apply ourselves to the anatomical and physiological problems presented in fractures of the neck of the femur, and arrive at agreement on better methods of complete fixation of these fractures, then, and only then, will the percentage of good end results increase.

## THE SIGNIFICANCE OF BLOOD CHEMISTRY TO ORTHOPAEDIC SURGERY \*

BY RUSSELL M. WILDER, M.D., ROCHESTER, MINNESOTA

*Division of Medicine, The Mayo Clinic*

The topic under discussion, involving as it does the relationship of humoral pathology to orthopaedic surgery, is so broad that its superficial consideration only will be attempted. A few years ago the author would have said that few points of contact existed between the metabolist and the orthopaedic surgeon. The bone setter of a former age was certainly not concerned with the chemical developments of the medical sciences, and his lineal descendant, or should we say his lineal ascendent, the orthopaedic surgeon, had so much to do with physical stresses and strains and the mechanical devices for relieving deformities as to find little time for the more abstract concepts of metabolism. At present, however, it is clear that the enterprises of metabolist and orthopaedic surgeon overlap at a number of points, and orthopaedic surgery would be far behind the march of modern therapeutic measures were it to fail to concern itself with subjects in the domain of metabolism, such, for example, as nutrition and growth.

The skeleton is not, as it seems to the medical student when he pursues his first dissections in anatomy, "as dry as bones". Likewise the various skeletal structures, although presenting numerous mechanical problems comparable to those of engineering, are by no means static, and thus differ fundamentally from the steel girders and other structural materials with which the engineer has to do. Bone is alive indeed, and like other living matter is in constant flux. The continuous wear and tear is compensated under normal conditions by a steady supply of calcium, phosphorus, protein-building stones, and other elements for the reconstitution of disintegrating skeletal structures. It is perfectly correct to speak of metabolism of bone, and it is self evident that the deformities presented to the modern orthopaedic surgeon—not excluding those due to trauma, tumors, or infection—are influenced by the nutrition of the bone. The successful union of fracture is obviously affected by humoral conditions, and a large variety of substances carried in the blood are known to be necessary for the health of bone.

Among the humoral factors entering into the metabolism of bone, calcium and phosphorus, vitamin D, the parathyroid hormone, and the growth hormone of the anterior lobe of the pituitary gland are outstanding. Information regarding other factors is still limited. We are very much alive to the significance of calcium, phosphorus, and vitamin D in the prevention of rickets and osteomalacia. It is probable that we are not as

\* Read before the American Orthopaedic Association, Washington, D. C., May 10, 1933.

alert as we should be in suspecting humoral deficiencies in osteoporosis. Vitamin C may play a part, and it is not improbable that relative deficiencies of various kinds are responsible for much of what we call senility, including the osteoporosis of senility. We have acquired some definite information on the subject of the parathyroid glands in metabolism of bone. An oversupply of parathyroid hormone produces the multiple fibrocystic disease known as generalized fibrous osteitis, or better, as parathyroid osteosis. We have excellent grounds for attributing to the eosinophilic cells of the anterior lobe of the pituitary gland a major rôle in the stimulation of the osteoblastic cells of bone. Acromegalia and gigantism, associated with eosinophilic pituitary tumors, are evidence of this. But suggestions have not been offered for the pathogenesis of many other abnormalities of bone. *Fragilitas ossium* (osteogenesis imperfecta), defined by Lobstein in 1833, is possibly the expression of a metabolic disorder. Individuals affected with this disease tend to be short and slender, and the basic defect is said to be inability to form osteoblasts. These are few in number and anomalous in structure, and apparently represent failure of certain primitive cells to differentiate as they should. Although suitable evidence is not at hand, one might suspect in this disease either a deficiency of the growth hormone or a deficiency of one of the vitamins.

Chemical analysis of the blood is a poor guide to the interpretation of any of these skeletal abnormalities. Methods for the detection of the hormones and vitamins in blood are not as yet available, and, although changes of the mineral constituents are noted in certain diseases of bone, these are inconstant and afford less reliable diagnostic criteria than some observers have supposed. Calcium is unequally distributed between the plasma and the corpuscles. Only traces are found in the latter and consequently the results of analysis must be expressed either for plasma or for serum,—usually for serum. The normal figure by the Kramer-Tisdall method, as modified by Clark and Collip, is from nine to eleven milligrams in each 100 cubic centimeters of serum. In the cerebrospinal fluid, and in ultrafiltrates of serum, the figure is only from four to six milligrams in each 100 cubic centimeters, which indicates that almost half of the calcium in the blood is bound to protein and therefore is not diffusible. The diffusible fraction is ionized to something more than fifty per cent. It appears that the question of calcium ionization has been given more emphasis than is justifiable, since the non-diffusible and diffusible fractions are in chemical equilibrium.

In postoperative tetany and other conditions of parathyroid deficiency, including rickets associated with tetany, the calcium falls to five or six milligrams in each 100 cubic centimeters of serum. With overfunction of the parathyroid glands high figures are obtained, but not constantly. In cases of parathyroid tumor, associated with the typical picture of parathyroid overfunction, the figure is usually high—sometimes even twice as high as normal—but in other cases, even when the calcium balance is negative, the values are normal. On the other hand, high calcium figures

may be obtained in a variety of diseases of bone for which there is no good evidence of parathyroid overfunction, and consequently hypercalcaemia is not diagnostic of parathyroid osteosis as has been supposed. Apparently any generalized or extensive destruction of bone may cause an increase in serum calcium, and high values are thus obtained at times in multiple myeloma and in extensive metastatic carcinoma.

The inorganic phosphorus in the blood is so equally divided between corpuscles and plasma as to permit using whole blood in its determination. However, if the corpuscles are allowed to lye, their organic phosphate esters are liberated, and in the plasma these are rapidly hydrolyzed, releasing additional phosphorus as inorganic phosphate ions. Under normal conditions, the values for inorganic phosphorus are from two and five-tenths to four milligrams in each 100 cubic centimeters of serum among adults, and as high as five milligrams in each 100 cubic centimeters of serum among young children, whose bones grow rapidly. High figures are obtained in tetany and low figures are obtained in parathyroid osteosis. A reciprocal relationship between calcium and phosphorus is often apparent in these diseases, so that feeding phosphates in cases of threatened tetany may depress the serum calcium and precipitate tetany. This is a matter of very practical significance.

The determination of the phosphatase activity of the blood serum adds information of some diagnostic significance in skeletal disease. Phosphatase is an enzyme which hydrolyzes phosphoric esters. It is widely distributed in the tissues and occurs abundantly in gastric mucosa, kidney, and the growing bone of youth. The distribution in bone is irregular; the enzyme is found particularly in the zone of provisional calcification and in the periosteum.

The method of Kay<sup>4,5</sup> for estimating the phosphatase activity of blood serum has found use with modifications by others.<sup>2</sup> The principle of the method is to incubate a substrate of sodium betaglycerophosphate in the presence of a satisfactory buffer to maintain a constant hydrogen-ion concentration. The extra phosphate formed by the hydrolysis of the glycerophosphate is a measure of the enzymatic activity of the serum. High figures are obtained for phosphatase in a variety of the skeletal diseases, including parathyroid osteosis, multiple myeloma, generalized carcinomatosis, rickets, osteomalacia, and Paget's disease. In focal osteitis fibrosa, in the cystic disease of bones of youth, and in non-skeletal disease, the phosphatase activity of the blood is not at all affected or only slightly affected.

Robinson's opinion of the rôle of phosphatase in the deposition of calcium phosphate in growing bones is that the osteoblasts and hypertrophic cartilage cells secrete the enzyme, and this, by hydrolyzing the phosphoric esters of the blood, brings about a local increase in the concentration of phosphate ions. The solubility product of the tertiary calcium phosphate in the blood is thereby exceeded and deposition of this salt occurs in the ossifying zone. The finding of an increased amount of phosphatase en-

zyme in the circulating blood, in generalized destructive diseases of bone, suggests its increased production, possibly in an attempt at compensation. The large amounts in the mucosa of the stomach and in the kidneys may in part account for the predilection of these organs for metastatic calcification.

It will be recalled that Shipley and his associates, in 1922, produced rickets in rats either by diminishing the phosphorus of the diet and supplying an optimal amount or an excess of calcium, or by reducing the calcium and maintaining the phosphorus of the diet. They concluded that a certain ratio of calcium to phosphorus is necessary to prevent rickets. The investigations of Howland and his coworkers, and those of Pappenheimer and others, confirmed this view and established the current opinion that the supply of calcium and phosphorus must not only be adequate but must be properly proportioned. There is good reason to believe that the advance of civilization has brought with it dietary habits which interfere with optimal conditions of nutrition in a variety of ways. Thus it is calculated that the diets of more primitive people contained not less than two grams of calcium daily, whereas the equivalent figure for the average American, not drinking milk, may frequently fall below the figure of forty-five-hundredths of a gram a day, which Sherman sets as an absolute minimum. Sherman and others urge the use of milk, or the addition of calcium salts to food, for human beings. This matter deserves special consideration in diseases of bone characterized by osteomalacia or osteoporosis, and in the healing of fractures. The large stores of calcium in the skeleton protect against acute manifestations of calcium deficiency, but the osteoporosis of old age, of hyperthyroidism, and of long standing chronic infections, and the not infrequent delay in the union of fractures imply that chronic deficiency of calcium is an important problem in public health.

What salt of calcium may be best for supplementing diets is a question recently receiving attention. It probably makes little difference provided a rich supply of vitamin D is added, but in most cases it seems best to provide phosphorus in suitable proportions together with the calcium, and for this purpose calcium phosphates are desirable. The calcium phosphates, however, are relatively insoluble, particularly in the alkaline medium of the intestine. The dibasic or secondary calcium phosphate has been recommended because of its being less insoluble than the tribasic or tertiary phosphate. The results of recent experiments of Higgins and Sheard seem to upset this view. The tribasic calcium phosphate proved far more satisfactory than the secondary calcium phosphate in the nutrition of young chicks which were deprived of vitamin D.

Another borderland of orthopaedic surgery is the treatment of diabetic gangrene, and questions on this subject remain unanswered. Gangrene, we are all agreed, is intimately related to the atherosclerosis with which it is frequently associated, but whether the diabetes causes the atherosclerosis, as Joslin teaches, or atherosclerosis comes first with dia-

betes as a sequela is not established. The evidence, the author believes, favors the latter view and makes atherosclerosis the horse and diabetes the cart.

The slow healing of wounds after amputation of an extremity of a diabetic patient is due partly to diabetes, if this is not treated, and partly to the diminished supply of blood resulting from atherosclerosis. Bennett reported observations on the healing of wounds of dogs made diabetic by pancreatectomy. The pancreas was removed under ether anaesthesia. The animals were supported by a suitable regimen and injections of insulin until they had recovered completely; then insulin was withheld and when the diabetic state was fully developed fresh abdominal incisions were made under local anaesthesia. As compared to the behavior of identical wounds of healthy animals, the healing of these wounds was abnormal. The tissues were oedematous, deposit of fibrin was delayed, and its amount was restricted. The cellular reaction was excessive and the exuded cells appeared to be toxic. New blood vessels were slow to form and more thrombosis than normal was noted in preformed vessels.

Trimble and Carey have shown that the true sugar content of muscles is slightly increased and that of the skin, in cases of diabetes, is increased as much as threefold or more over the normal; they assume that this is a factor of considerable importance in the altered healing of wounds of diabetic subjects. The values for fermentable sugar of the muscles of the amputated extremities of diabetic patients were not found to be higher than normal.<sup>6</sup> The analyses appear in Table I. It is to be noted that the blood sugars were higher than normal, but not extremely high. The patients had been prepared for operation; their urines were sugar-free, but the attempt had not been made to reduce the blood sugar further than it would naturally fall with the control of glycosuria.

TABLE I  
REDUCING VALUES OF ALCOHOL EXTRACTS OF MUSCLE FROM DIABETIC PATIENTS  
TREATED WITH INSULIN \*

Case	Milligrams for Each 100 Grams			
	Before Fermentation	After Fermentation	Fermentable Sugar	Blood Sugar
1. ....	99			225
2. ....	58	26	32	
3. ....	56	7	49	145

\* General anaesthesia; tissue removed at operation; blood taken as near time of removal of tissue as possible.

Clinical experience has indicated that, when glycosuria is arrested, wounds of patients with diabetes heal as well as might be expected of wounds of normal subjects, even when the blood sugar is not entirely nor-

mal. The application of insulin locally or by injection subcutaneously near the wound is of little, if any, additional value. The essential factors are the control of glycosuria and the avoidance of acidosis and dehydration. In cases of diabetes with atherosclerosis, and in some without evidence of vascular abnormality, a higher than normal threshold for glucose often develops. In such cases, if treatment is intensive enough to force the blood sugar down to values considered normal in health (below 110 milligrams in each 100 cubic centimeters of blood), untoward symptoms are occasionally provoked. Intermittent claudication in these circumstances has been seen and symptoms suggesting angina pectoris have often been reported. It is not improbable that the tissues in cases of chronic diabetes require a higher than normal glycaemic level, which, if true, may mean that the healing of wounds will be less satisfactory when hyperglycaemia is combated too vigorously. The matter deserves further study. What is wanted is an investigation of the sugar content of the skin of patients with a high renal threshold, together with a study of the effects of hypoglycaemia, either relative or absolute, on the healing of wounds.

The author regrets his inability at this time to treat this subject more adequately. Significant matters such as the uric acid metabolism of gout, have been given no attention, but the few conditions to which he has alluded attest, he is sure, the significance of humoral pathology in orthopaedic surgery.

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## HIP-FUSION OPERATION

BY FREMONT A. CHANDLER, M.D., CHICAGO, ILLINOIS

The operative fusion of many types of pathological hip joints is rapidly becoming the treatment of choice. This is especially true in cases of tuberculous infection. Intra-articular, extra-articular, and combined types of operations have been described and are widely used, the general trend being toward a more radical procedure which will obliterate the hip joint and permit an extensive area of fusion to develop. This may be accomplished by the following operation.

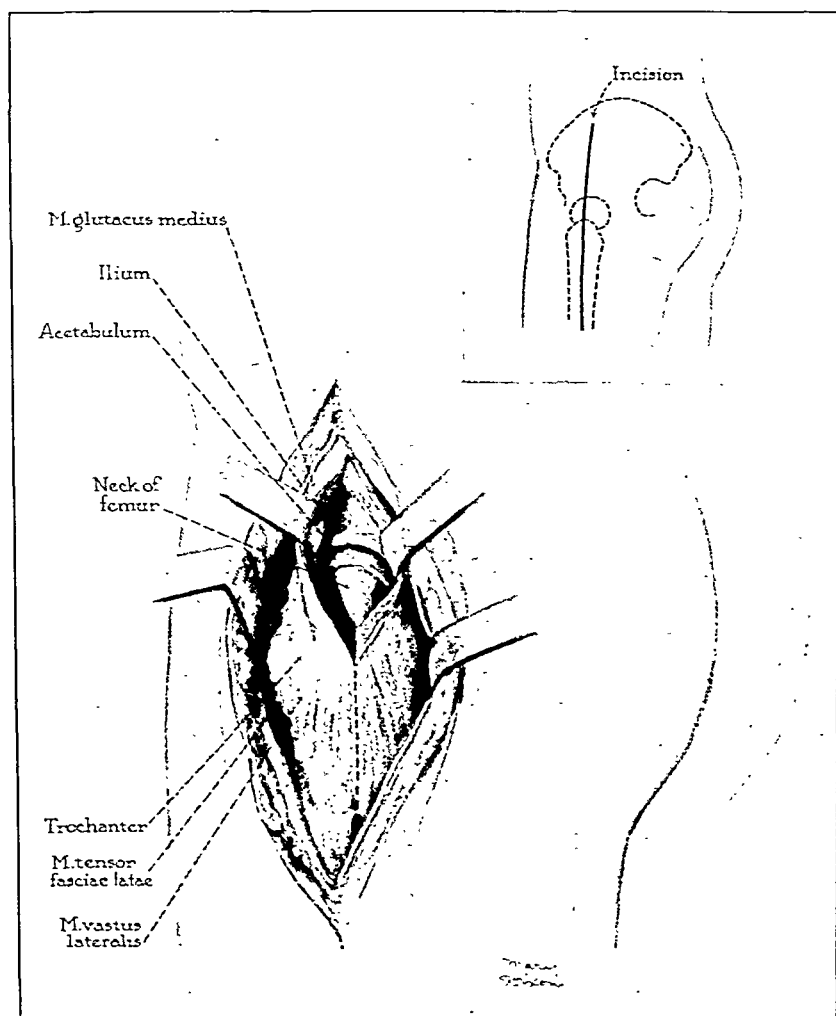


FIG. 1

Straight lateral incision exposing the greater trochanter, femoral neck, and superior margins of hip joint.



## TECHNIQUE

The patient is placed on the well side at an angle of about forty-five degrees. A long vertical incision (Fig. 1) is made over the lateral aspect of the hip, extending from the crest of the ilium directly over the greater

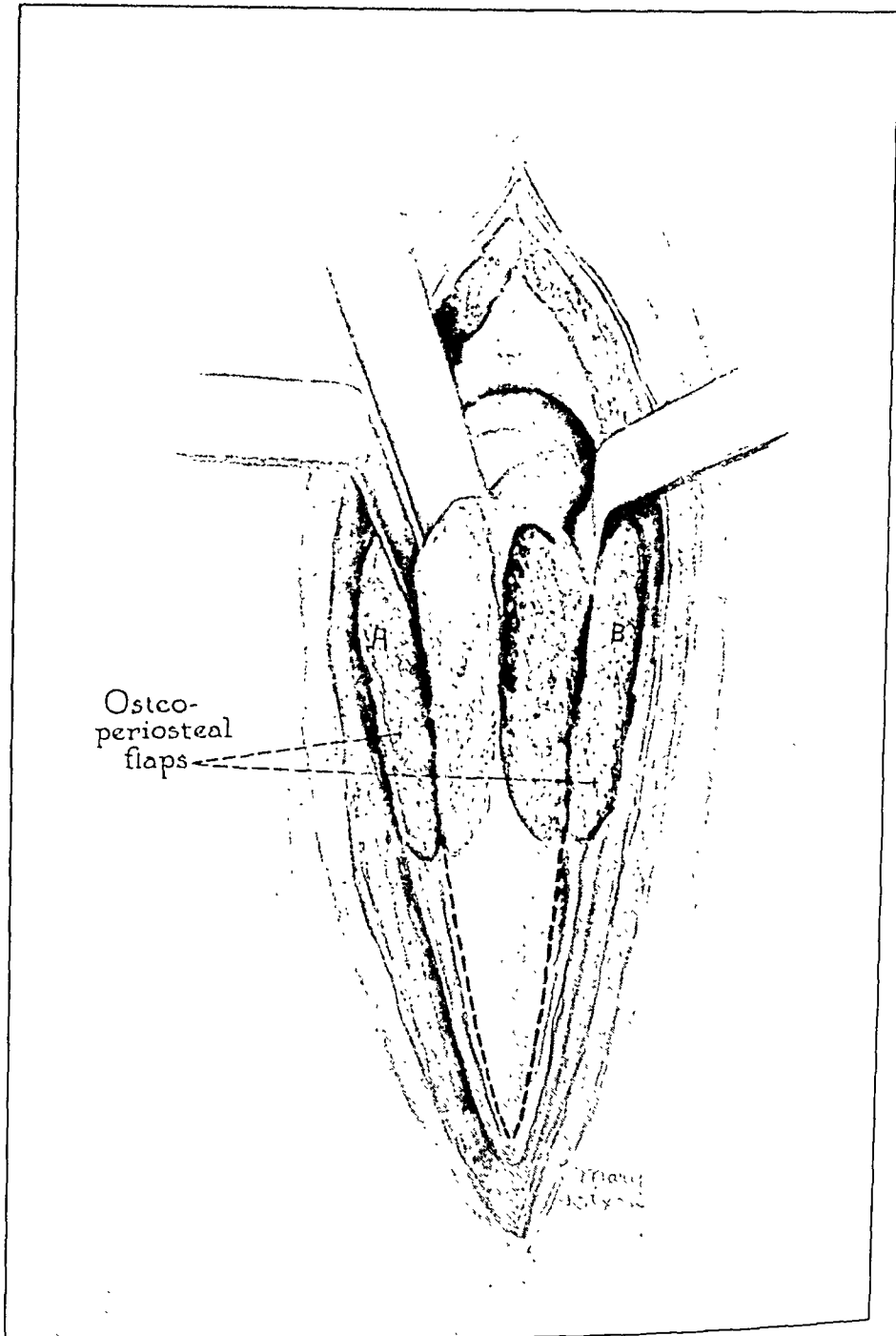


FIG. 2

Heavy grafts (*A* and *B*) of cancellous bone are reflected from the antero-lateral and posterolateral aspects of the greater trochanter. The periosteal and muscular attachments of these grafts are not disturbed. A massive graft including the greater trochanter, lateral surface of the neck, and a portion of the cortex of the shaft is removed by converging cuts.

trochanter to the juncture of the upper and middle thirds of the thigh. The incision is carried through the subcutaneous tissue and splits the tensor fasciae latae, exposing the lateral aspect of the greater trochanter, the gluteus medius, and the origin of the vastus lateralis of the quadriceps femoris. The incision is then carried through the periosteum and origin

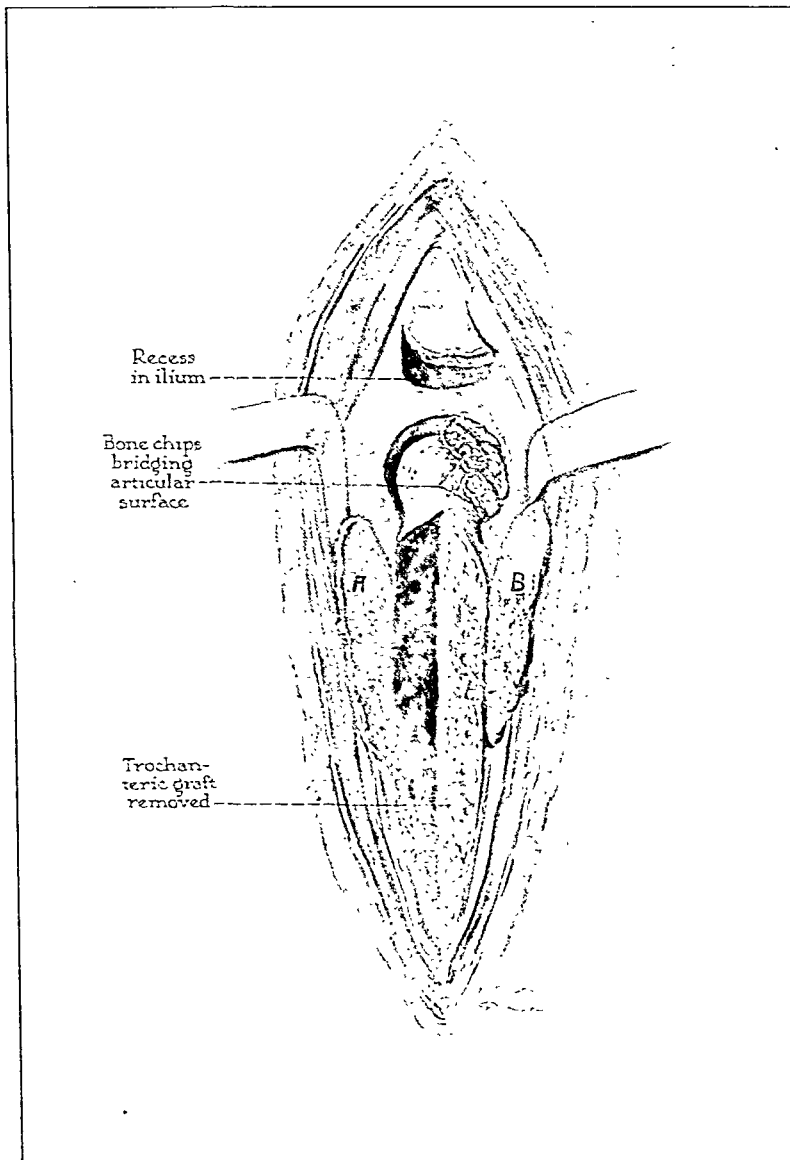


FIG. 3

Trochanteric graft removed. The cartilage of the head and acetabulum is removed and replaced by cancellous bone chips. A recess is made in the ilium above the margin of the acetabulum.

of the vastus lateralis and through the mid-portion of the gluteus medius, parallel to the muscle fibers. It is deepened to the superior aspect of the femoral neck and crosses the hip joint at right angles to the upper acetabular margin. Heavy bone flaps (Fig. 2, A and B) attached to the perios-

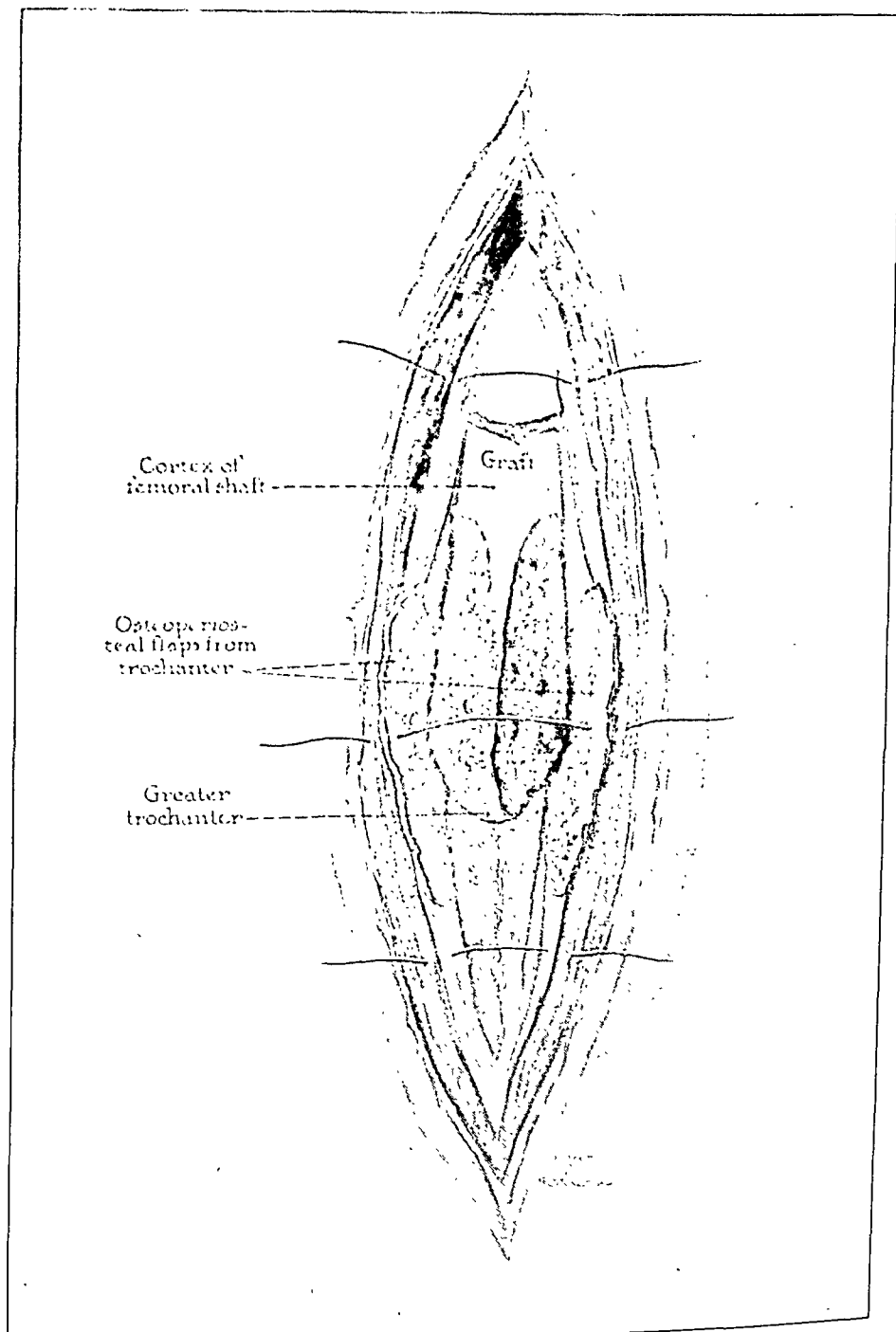


FIG. 4

The trochanteric graft is turned end for end and shaped for maximum contact. The cortical portion is then driven firmly into the recess on the lateral surface of the ilium. The thigh is abducted to establish firm contact with the graft. The osteoperiosteal grafts are firmly sutured over the free end of the massive trochanteric graft and the wound closed without drainage.

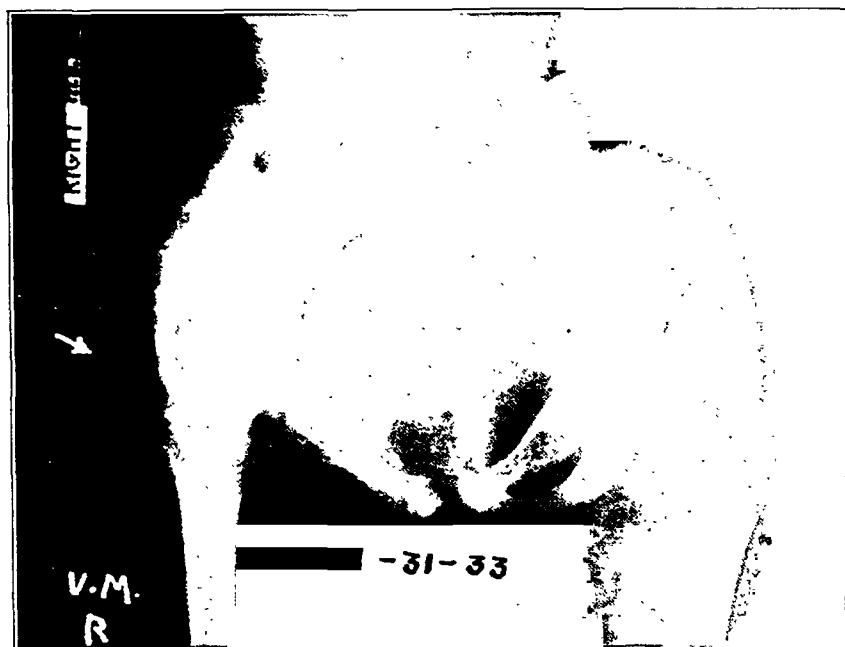


FIG. 5  
Tuberculosis of right hip of five years' duration.

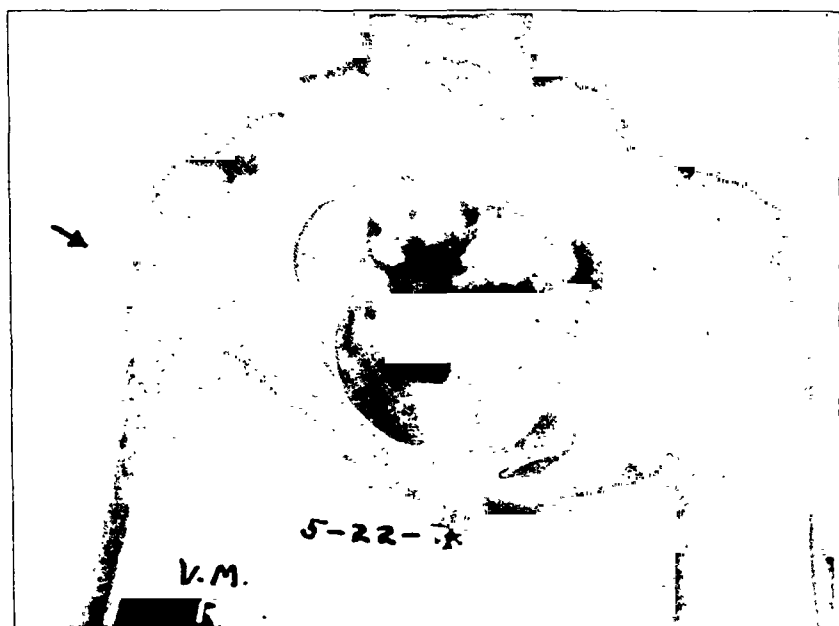


FIG. 6  
Fusion at sixteen weeks after transplant of trochanter as described.

teum and muscle insertions are then elevated from the anterolateral and posterolateral aspects of the greater trochanter and the upper end of the shaft. These bone flaps should be generous in size and should extend well to the anterior and posterior portions of the base of the femoral neck. The capsule and periosteum of the femoral neck are then elevated anteriorly and posteriorly from the line of incision. These flaps are retracted anteriorly and posteriorly, exposing the trochanter. A massive graft, consisting of the main portion of the greater trochanter and the lateral cortex of the upper portion of the femoral shaft (Fig. 2), is removed by parallel cuts which converge in cross section through the cortex and cancellous tissue. This graft extends from the mid-portion of the femoral neck to a point about five inches distal to the tip of the greater trochanter, and is about two-thirds the width of the upper end of the shaft. Its thickness is about one-half the diameter of the shaft.

Following the removal of this graft (including the greater trochanter), the upper lateral aspect of the femoral neck and head presents in the wound (Fig. 3). The capsule is stripped from the superior margins of the acetabulum. A curved arthroplasty chisel is then used to denude the surface of the femoral head and the opposing articular cartilage of the acetabulum. Fragments of cancellous bone taken from the graft bed are firmly pressed into this space. A hinged flap of bone is then elevated from the outer table of the ilium, just above the acetabular margin, and a recess made in the ilium to receive the cortical portion of the graft. The graft is then turned end for end and the cortical portion driven into the recess above the acetabulum. If the thigh is adducted during the fixation of the graft, better contact can be secured. On returning the thigh to a neutral position or to slight abduction, the trochanteric portion of the graft will make contact with the graft bed in the upper end of the femur (Fig. 4). With the graft in place, the hinged osteoperiosteal flaps removed from the trochanter are brought into position, covering the free end of the graft. The periosteum and origin of the vastus lateralis are sutured. The fascia, subcutaneous tissues, and skin are loosely sutured and a double spica cast applied to hold the thigh in the position of election until bony fusion is complete.

This operation combines features found in intra-articular and extra-articular types of fusion operations. The exposure of the graft and hip joint is obtained with a minimum of trauma. A massive graft, firmly fixed in the ilium and in wide contact with the neck of the femur, splints the joint and provides wide, bony contact for fusion.

# THE RESULTS OF OPERATIVE FIXATION OF TUBERCULOUS SPINES

BY DON KING, M.D., ANN ARBOR, MICHIGAN

*From the Department of Surgery, University of Michigan*

This report is based on an inquiry into the present condition of ninety-three University Hospital patients who had spine-fusion operations for vertebral tuberculosis during the six-year period, July 1925 to July 1931. The operation was performed on those patients whose general condition was considered good and who showed no gross evidence of dissemination. Extravertebral osseous tuberculosis or draining sinuses outside the field of operation were not considered contra-indications.

The preoperative treatment was variable; in the majority of cases operation followed prolonged cast, brace, or Bradford-frame régime, in others operation was done after only a few days of frame care. The post-operative routine included Bradford-frame régime (average time eight months) with heliotherapy and high vitamin and high caloric diet. Before patients were allowed to become ambulatory, back braces were fitted which were worn for an average of about two and one-half years.

For this study we have been able to establish contact with eighty-four of the ninety-three patients. The majority of the results have been ascertained by check-up examinations in our own Clinic. In a few cases, however, this has been impossible and we have had to depend on questionnaires and examination by local physicians.

TABLE I

Total number of cases . . . . .	93
Total number of operations . . . . .	96
Males . . . . .	49 or 52 per cent.
Females . . . . .	44 or 48 per cent.
Result unknown . . . . .	9
Total number of cases in which end results are reported . . . . .	84

The time elapsing between operation and check-up is, for seventy-six of the eighty-four patients, between two and six and one-half years; for the remaining eight, between one and one-half and two years.

## *Types of Operation—Preoperative Complications*

Of the ninety-three patients there were forty-nine males and forty-four females. The Hibbs type of plastic fusion operation was used sixty-two times. In twenty-four cases the Albee tibial-graft technique was employed, the graft being fused to the base of the spinous processes and laminae. For the remaining ten lesions, a type of Hibbs fusion, reenforced by ilial or tibial grafts, was used. There was a positive history of tuberculous contact in twenty cases. Thirty-nine of the patients had tuberculosis elsewhere. Nine patients showed definite evidence of transverse myelitis.

*Classification of Results—Method Employed*

## 1. Good result:

A patient without subjective complaints or increase in deformity who has a solid fusion both from clinical and roentgenographic examination.

## 2. Fair result:

A patient who has a moderate amount of pain or weakness, but is able to be up and about. The deformity is not increasing.

## 3. Poor result:

a. A patient whose spine is so painful that he is not ambulatory.

b. A patient whose deformity has increased since operation, although he may be asymptomatic.

c. A patient whose death was directly attributable to the operation.

Using this method of classification, we find fifty-eight, or 69 per cent., of our eighty-four patients have a good result; two, or 2.3 per cent., have a fair result; and sixteen, or 19 per cent., have a poor result.\* (See Table II.)

TABLE II

Results	Number	Per Cent.
Good	58	69.00
Fair	2	2.38
Poor	16 { 9 alive 7 dead from operation	19.00
Dead	8—no relation to operation	9.52
Total	84	99.90

Among the fifty-eight good results are two whose spines are in excellent condition but in whom the result should be somewhat qualified. The first is a man of thirty-seven years who developed postoperatively a severe polyarticular arthritis which has produced a bony ankylosis of both knees and one hip. The second is a boy of sixteen years who now has recurrent trophic ulceration of the sole of the foot because of a cord injury during operation. There are nine patients with poor results.

TABLE III  
RESULTS LISTED BY DECADES

Age Period	No. of Patients	Good		Fair		Poor		Dead	
		No.	Per Cent.	No.	Per Cent.	No.	Per Cent.	No.	Per Cent.
1-10	18	13	72			3	17	2	11
10-20	20	15	75			2	10	3	15
20-30	22	14	63			3	14	5	23
30-40	13	11	84	1	8			1	8
Above 40	11	5	46	1	9	1	9	4	36
Total	84	58	69	2	2.3	9	10.7	15	18

\* Figuring on a basis of seventy-six instead of eighty-four patients (omitting eight dead, no relation to operation) gives the following results: good, 76 per cent.; fair 3 per cent.; poor, 21 per cent.

To these we must add an additional seven whose deaths are directly attributable to the operation, giving a total of sixteen, or 19 per cent. Table III gives the ages of the patients by decades with the end results in each group. The highest percentage of good results was obtained in the thirteen patients of the fourth decade (84 per cent.). The mortality

TABLE IV  
ANALYSIS OF DEATHS

1. Directly attributable to operation.....	7
Immediate, operative shock.....	2
Embolism (seven days postoperative).....	1
Development or flaring up of other foci, directly attributable to operation:	
Meningitis.....	1
Sepsis in wound.....	1
Bilateral renal.....	1
Pulmonary.....	1
2. Dead of dissemination (no apparent relation to operation).....	8
Tuberculosis.....	2
Meningitis.....	2
Kidney.....	1
Multiple foci.....	3
Total number of deaths.....	15

TABLE V  
NEUROLOGICAL RESULTS IN PATIENTS SHOWING SPINAL-CORD COMPLICATIONS  
BEFORE OPERATION

Case	Symptoms	Duration	Onset	Outcome
1.	Marked spastic gait. Sensory level at umbilicus.	3-6 months	Gradual	Complete cure. Neurological examination negative.
2.	Incontinence, frequency, painful bladder. No spasticity.	3 months	Sudden	Complete cure.
3.	Unable to walk. Marked spasticity. No sensory paralysis.	4 months	Gradual	Good gait. Slight weakness left leg. Subjectively cured.
4.	Unable to walk. Marked spasticity. Sensory level at seventh dorsal.	1 week	Sudden	Good gait. Subjectively cured. Persistent Babinski.
5.	Unable to walk. Bladder and rectum sensory below umbilicus.	3 months	Sudden (3-5 days)	Complete subjective and objective cure.
6.	Weak legs 2½ years. Unable to walk 2 years. Bladder paralysis 2 years. Sensory changes.	2½ years	Gradual	Completely cured. Neurological examination negative.
7.	Spasticity, moderate. Sensory level at tenth dorsal.	2 years	Not given	Died of pulmonary tuberculosis soon after leaving hospital.
8.	Spasticity lower extremities occurred twice, second time with sensory changes.	Not given	Not given	Completely cured each time.
9.	Cervical Pott's disease. Diffuse spasticity of arms, legs; unable to walk or feed self. Sensory changes.	1 month	Sudden	Complete cure. Neurological examination negative.



in patients beyond the age of forty is high, 30 per cent. Among children the percentage of good results is around 75.

In addition to the three immediate postoperative deaths (two from shock, one from embolism), there are four which occurred soon after and seemed directly attributable to the operation. Eight others (Group 2, Table IV) show no apparent relation between operation and death.

#### *Patients with Preoperative Neurological Complications (Table V)*

One of this group of nine patients is dead. Eight are subjectively cured. On examination two of these have mild spastic weakness of the lower extremities. In six cases the paralysis had either partially or completely cleared while undergoing preoperative Bradford-frame régime, indicating little relationship between spine fusion and cure of the paralysis.

#### *Factors Causing Further Deformity*

Six patients in the poor-result class showed increase in the deformity following the fusion because of further vertebral body erosion (five children, one adult). All had a solid posterior ankylosis both by clinical and roentgenographic examination. In one case the kyphotic area was exposed (two years after fusion) and a very solid, satisfactory ankylosis was found.

In the unfused spine the most important factors in the prevention of further kyphosis are cessation of body erosion and adequate anterior vertebral-body contact. In the fused spine these factors are aided somewhat by the posterior bony bridge. Superincumbent weight produces considerable bending force at the apex of the kyphos through its proximal arm. Such a bending force continuously exerted on a living, plastic, posterior bony bridge will always cause bending or fracture with further angulation, if there is dead space to be filled anteriorly.

#### SUMMARY

1. Sixty-nine per cent. of eighty-four patients who have had fusion operations for tuberculosis have no complaints, have a solid posterior fusion, and show no increase of deformity.

2. Eighteen of these patients were, at the time of operation, from one to ten years of age. Seventy-two per cent. of this small group have an excellent result, indicating that for children the operation is safe and effectual.

3. Eighteen per cent. of these eighty-four patients are dead.

4. The stability of a kyphos is mainly dependent upon adequate anterior vertebral-body contact. Correction obtained by abduction of its jaws causes instability by producing a dead space in the diseased area. Posterior spine fusion does not restore sufficient stability to maintain correction obtained in this manner.

5. Eight of nine patients with preoperative neurological complications from cord pressure were subjectively cured. There is probably little relation between their operations and the disappearance of symptoms.

# ACROMIOCLAVICULAR DISLOCATION: AUTOPLASTIC RECONSTRUCTION

BY CHESTER C. SCHNEIDER, M.D., MILWAUKEE, WISCONSIN

Complete dislocation of the acromioclavicular joint is a more disabling injury than is commonly believed and, unless surgically restored, is permanent in character. Untreated cases of complete dislocation result in an inefficient shoulder, more or less incapable of manual effort in the elevated position. The shoulder is weak, unstable, and difficult to control, these factors of disability being particularly evident to persons whose employment or diversion is of a vigorous nature.

## AUTOPLASTIC RECONSTRUCTION

That the modern trend in reconstructive surgery is toward the employment of living autogenous tissues seems safe to presume. That the use of these substances will actually survive seems indicated by their increasing popularity as experience with them accumulates. In the reconstruction of the acromioclavicular joint the author prefers practically exclusively the use of fascia lata taken from the lower two-thirds of the thigh so as to include the iliotibial band. The fascial strip, eight inches long and three-quarters of an inch wide, tapered at each end, is re-

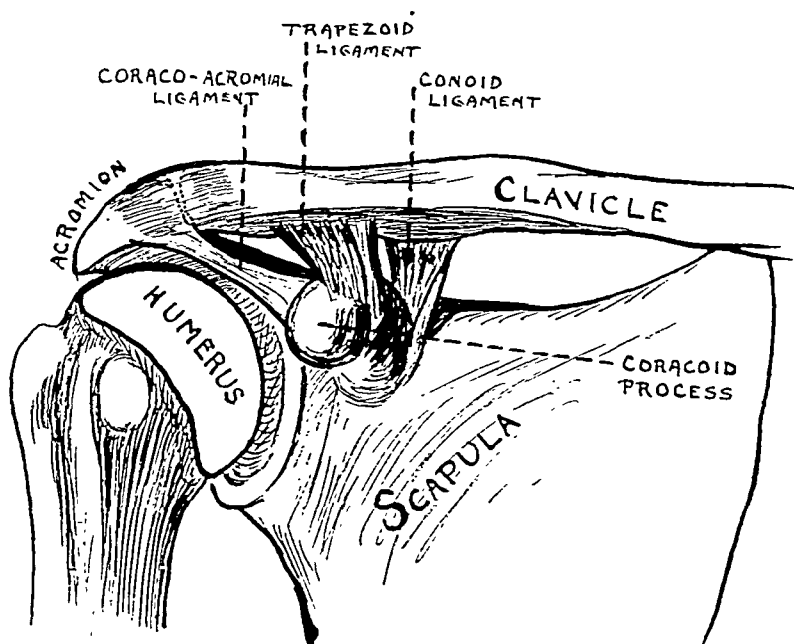


FIG. 1  
Normal shoulder.  
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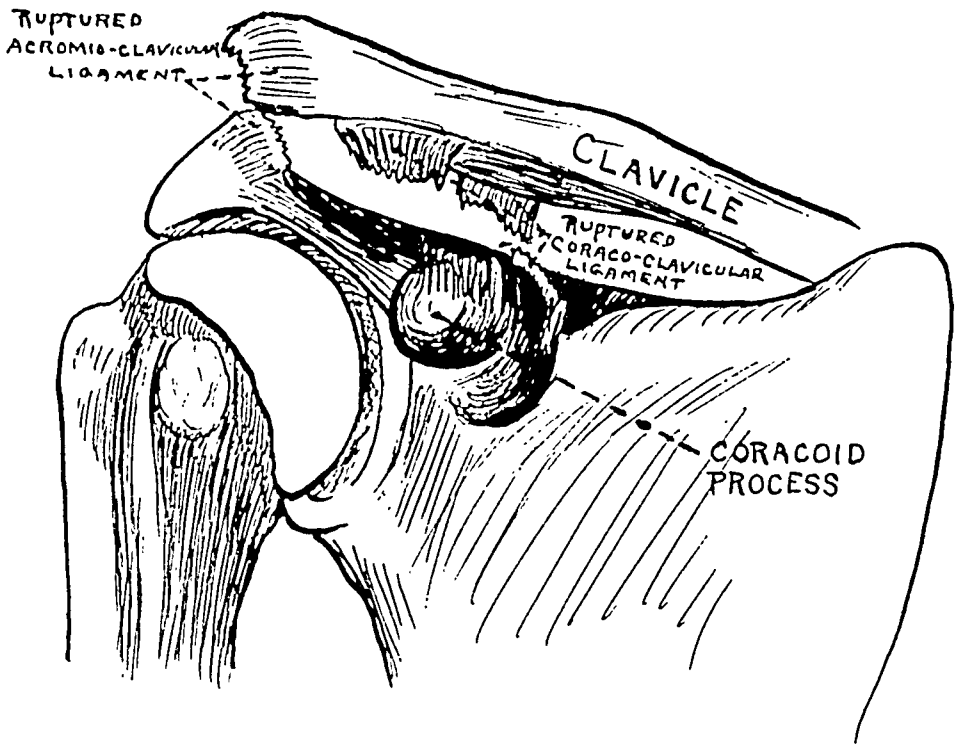


FIG. 2

Complete acromioclavicular dislocation.

moved and split longitudinally into a one-half-inch and a one-quarter-inch piece. These are placed in saline solution and the fascial sheath closed with a continuous No. 1 chromic catgut suture, followed by skin closure.

Approach to the acromioclavicular joint and coracoid process is made through a four-inch incision at the inferior outer margin of the clavicle, curved downward at the anterior margin of the deltoid. The acromioclavicular joint is exposed and the coracoid process identified. The superior acromioclavicular ligament is dissected off of the upper surface of the acromion from the articular surface lateralward about one-half an inch. Two three-sixteenths of an inch drill holes, equidistant (three-eighths of an inch) from the articular margin, are made in the acromion; also, two similar holes are drilled in the clavicle the same distance from the joint. The articular cartilage of the joint is left intact because Cadenat has shown that there is a limitation of forward projection of the arm and a slight decrease in the amplitude of the movements of abduction when the acromioclavicular joint is ankylosed.

Restoration of the inferior acromioclavicular ligament is accomplished with a mattress suture of the one-quarter-inch fascial loop, each end of which is carried downward through a clavicular drill hole, lateralward across the inferior surface of the joint, and up through its respective drill hole in the acromion. The ends of this loop are then crossed on the superior surface of the acromion and sutured to each other with twisted silk (Fig. 3). This procedure can be performed with facility by employing the suture threader devised by Gratz.

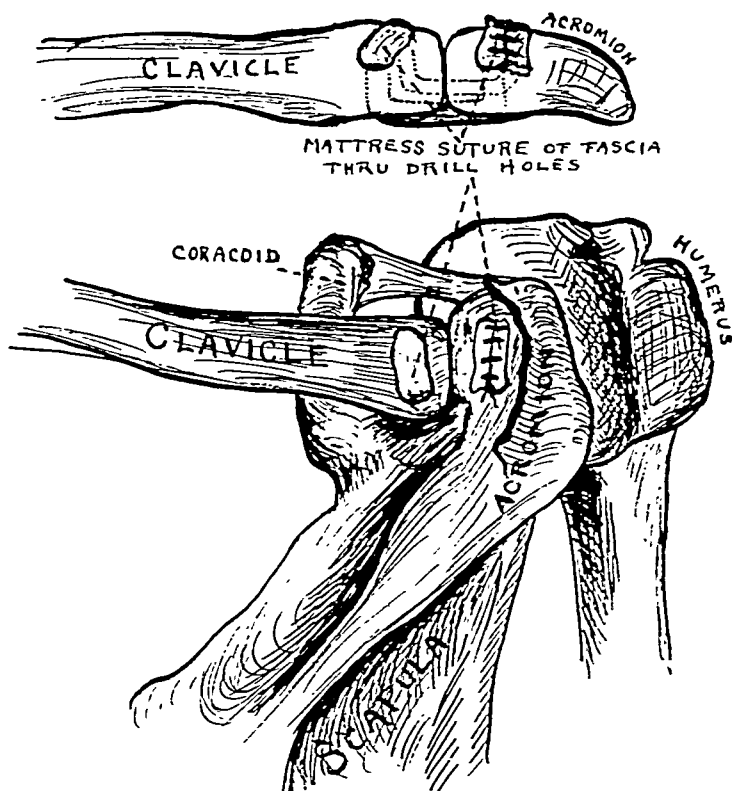


FIG. 3

Superior view of shoulder; first stage of reconstruction.

Next the coracoclavicular ligaments are reconstructed by carrying the one-half-inch fascial strip, threaded on a Gratz or a Gallie needle, under the inferior surface of the coracoid process and upward behind the clavicle subperiosteally at the site of insertion of the trapezoid, and crossed on the superior surface of the clavicle where the loop, under tension, is sutured with braided silk. The ends of this loop are drawn along the superior surface across the acromioclavicular joint and sutured together with silk to the acromial end of the acromioclavicular ligament, previously dissected up, thus restoring the ligament.

In this manner all the ligaments responsible for maintaining the integrity of the acromioclavicular joint have been rebuilt, and the clavicle is held firmly in position (Fig. 4).

The muscle and skin are closed in layers, the wound dressed, and a Dillehunt cast applied for immobilization. This cast (Fig. 5) is composed of arm, forearm, and torso segments applied separately and united to each other, while the involved shoulder is held as high as possible to relieve the strain on the repaired joint. The cast is removed in six weeks, followed by rehabilitation therapy. Full function should be recovered in three months.

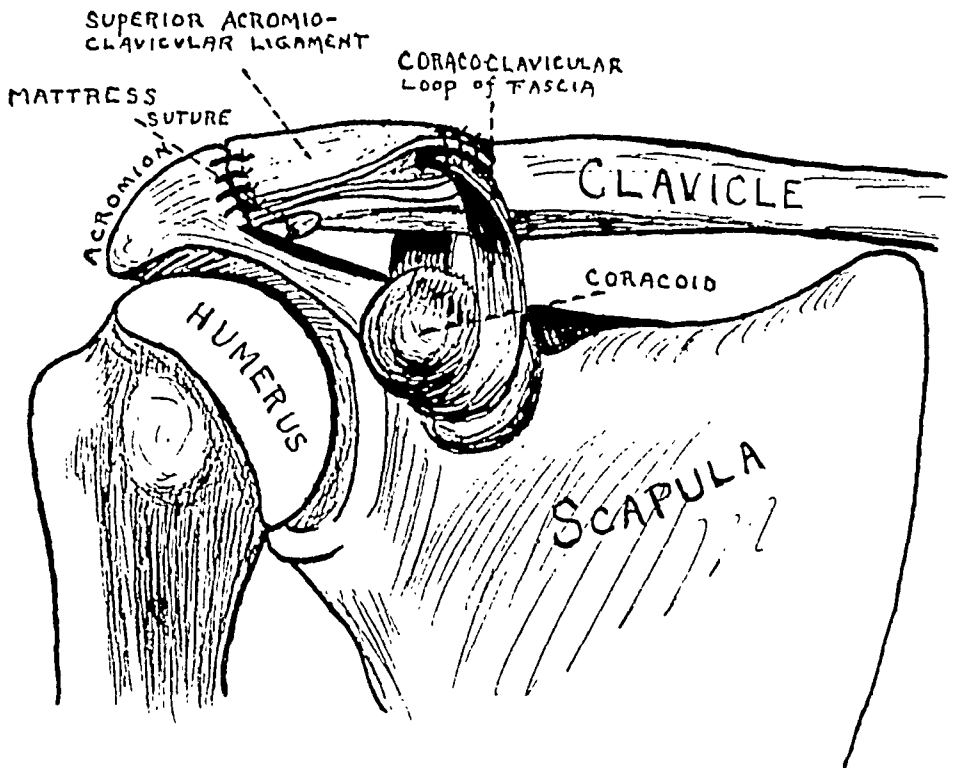


FIG. 4

Completed reconstruction of acromioclavicular joint.

The following two cases are cited to illustrate the type of individual upon whom the procedure has been employed successfully:

CASE 1. E. H., male, aged twenty-three, professional acrobat, sustained complete acromioclavicular dislocation while doing an acrobatic trick, November 21, 1927. Unable to continue his profession, he had been out of employment seven weeks when first seen by the author.

Physical examination revealed marked upward displacement of the outer end of the right clavicle, with excessive motion of clavicle on the acromion. There was marked pain at the acromioclavicular joint when vigorous motions of any kind were attempted.

An autoplasmic reconstruction operation, according to the technique described, was performed on March 17, 1928. Patient left the hospital eight days after the operation and the wounds entirely healed in three weeks. Light exercises were commenced on May 7, 1928, and vigorous exercises were prescribed two weeks later. Before the expiration of three months, June 9, 1928, the patient was doing push-ups and hand-stands. All motions at the shoulder were perfect and the contour of the shoulder was normal. The patient subsequently returned to the stage in a slow-motion acrobatic act.

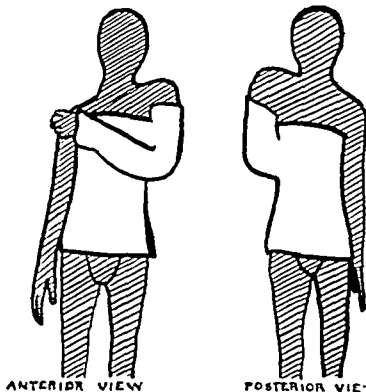


FIG. 5

Showing cast for acromioclavicular immobilization (Dillehunt).

CASE 2. C. W., male, aged thirty-six, professional rodeo rider, sustained a complete acromioclavicular dislocation on August 30, 1931, when he was thrown from a horse, landing on his left shoulder. The shoulder was at once completely disabled.

Physical examination revealed marked upward displacement of the distal end of the clavicle on the

acromion, with excessive mobility of the bones on each other. The entire shoulder was swollen and painful, and there was complete absence of voluntary motion.

An autoplasmic reconstruction operation, according to the author's technique, was performed on September 2, 1931. The patient remained at the hospital until October 5, 1931. All dressings were removed on November 2, 1931. There was complete range of motion, normal contour, and excellent power (Figs. 6, 7, 8, and 9). The patient returned to his former vocation of rodeo rider.

#### SUMMARY

1. An autoplasmic reconstruction of the acromioclavicular joint for acute or chronic dislocation, using fascia lata and iliotibial band, is described.

2. Two cases of reconstruction of the acromioclavicular



FIG. 6

Case 2. Roentgenogram before operation.



FIG. 7

Case 2. Roentgenogram after operation.



FIG. 8

Case 2. After operation.



FIG. 9

Case 2. After operation.

joint in professional athletes, using the author's method, are reported.

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# VERTEBRAL EPIPHYSITIS AND OSTEOCHONDRITIS

BY PAUL O. SNOKE, M.D., LANCASTER, PENNSYLVANIA

*From the X-Ray Department of the Lancaster General Hospital*

The object of this presentation is to review the work of Scheuermann and Schmorl as read in the original language; to then present three cases of dorsal kyphosis with comments thereon.

This paper will not deal with the embryological, anatomical, physiological, or historical aspects of the spine or spinal diseases. Readers so desiring will find appropriate articles dealing with these specific phases in the bibliography.

In reviewing the literature, articles were found dealing with diseases of the intervertebral disc, dorsal juvenile kyphosis, vertebral epiphysitis, prolapsus of the nucleus pulposus, and other conditions; all treated the same problem, but presented conflicting views. This confusion may have resulted from failure of the authors to read Scheuermann's original article and Schmorl's publications in the original language, for much that has been written in our periodicals seems to have been based on other than first sources, so that the original contentions of the authors have been lost or misapprehended.

From Scheuermann's original article we receive the following description of a clinical entity, "*Die Lehrlings Kyphose*" (The Apprentice's Kyphosis):

1. Clinical—Round back (dorsal kyphosis); painful back; irreducible deformity (contradistinction of *dorsum rotundum*); found especially in males from fourteen to eighteen years of age.
2. Roentgenographical—An area of osteitis on the diaphyseal side of the epiphyseal line; wedging of vertebra in the dorsolumbar region.

Analysis of Scheuermann's work is relatively easy, but when one turns to the reading and translation of Schmorl's work it becomes very difficult because of his involved diction. Furthermore, it must be remembered that Scheuermann is a clinician while Schmorl is a pathologist, having recorded observations on 7000 vertebral columns removed at autopsy. With this wealth of material from which to draw, one can well understand his difficulty in presenting one phase of his subject without digressions.

Schmorl's description is as follows:

1. "*Ausbuchtungen*" (outpouchings of the nuclear substance into the spongiosa) through
2. Congenital or traumatically produced orifices in the cartilaginous plate.
3. The kyphos is the result of loss of nuclear substance, which



- interferes with the physiological function of the spine, causing
4. Failure of endochondral growth in the cartilaginous interface and wedging. He does not use the term osteochondritis.

One must come to two conclusions:

First, Schmorl saw the termination of the disease Scheuermann described. There exists, however, a gap in our knowledge in that we do not know the subsequent course of Scheuermann's cases. It would be invaluable if we could trace the eighty-six cases he reported and reexamine them eleven years after their original observation.

Second, there may be three or more separate diseases or manifestations of the same disease which, until the present time, have not been separately identified. As Dr. William Evans of Detroit suggests, there may be three pathological entities: (1) vertebral epiphysitis (Scheuermann); (2) osteochondritis of the cartilaginous interface (Schmorl); (3) a combination of these two. It is not to be supposed that only these three

exist, or that they represent three etiological entities. They may or may not simply present roentgenographic evidence of pathology of several origins.

The following three cases are presented with an attempt to analyze the group to which they belong. The study of these cases and the conclusions drawn therefrom cannot be regarded as final, but only as additional information upon a difficult problem.

#### CASE REPORTS

CASE 1. V. D., a white female, aged twenty years, a school teacher, of slender physique, was referred to the Hospital by Dr. J. L. Atlee, Sr. on February 2, 1929, for a roentgenographic examination of the spine. Her complaint was "pain in the back" (dorsolumbar region) of several years' duration, with no known traumatic or infectious cause. The pain was accentuated by menstruation and may be more adequately described as an ache. Rest in bed alleviated it, but did



FIG. 1

Case 1. Vertebral epiphysitis (healing stage). Recent films of first, second, third, and fourth lumbar vertebrae. Note notching anteriorly, and evidence of abnormal pressure posteriorly.

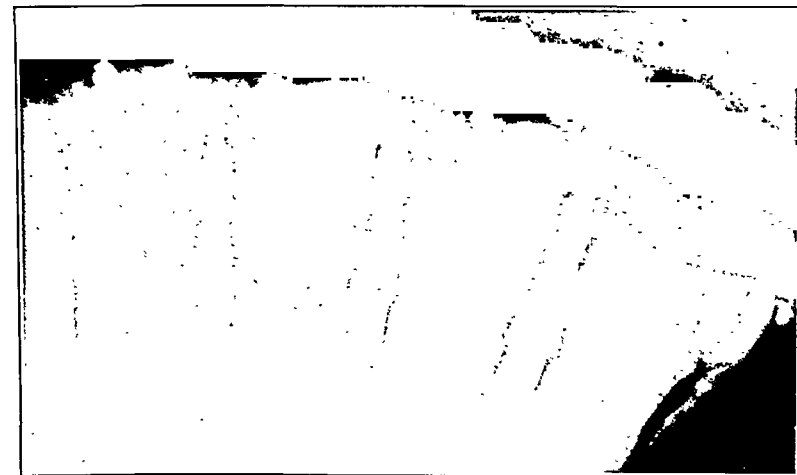


FIG. 2

CASE 2. Late stage of vertebral osteochondritis with wedging, narrowing, and numerous nuclear prolapses.

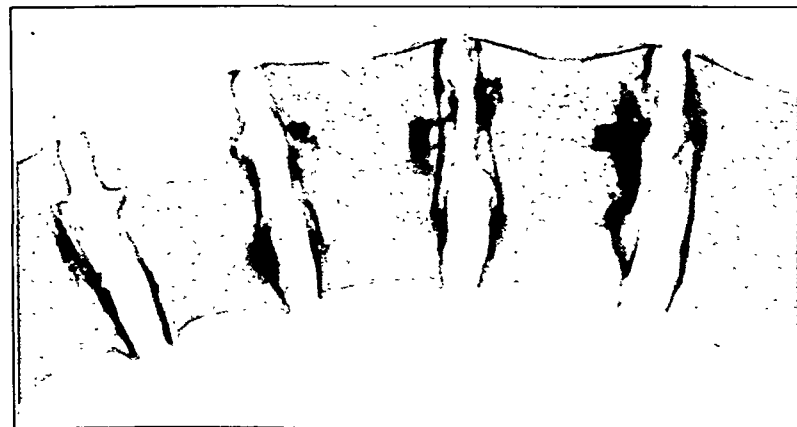


FIG. 3

CASE 2. Roentgenogram of section of specimen removed at autopsy.



FIG. 4

CASE 3. Vertebral epiphysitis and osteochondritis. Typical Scheuermann's disease, noting at arrow with definite wedging; also Schmorl's nuclear prolapse.

not cure it. During the intervening three years the pain gradually disappeared during the intermenstrual interval except after heavy lifting.

Examination revealed a thin, pale, fragile, young woman, with loss of the lumbar lordosis and replacement by slight kyphosis in the painful area. Otherwise, her physical condition was not noteworthy.

Roentgenograms revealed notching of the anterosuperior edges of the first, second, third, and fourth lumbar vertebrae in the position noted by Scheuermann, with wedging of the first and third vertebrae. The edge produced by the epiphysis remained intact. The intervertebral discs were narrowed, but there were no nuclear prolapses. The patient was reexamined periodically for three years. The punched-out area was unchanged, with slight peripheral calcification and the vertebral interfaces definitely irregular and calcified (Fig. 1).

We believe that this is a case of true epiphysitis, diagnosed after the union of the epiphyses. The triangular shadow of the epiphysis is only seen from fourteen to eighteen years of age. Our patient was twenty; therefore, she should present a later stage in the course of this disease. It is noteworthy that no prolapsus of the nucleus pulposus exists; and the illustrations of Scheuermann's original article do not show this prolapse.

CASE 2. L. S., a tall, stalwart, white male, aged thirty-eight years, while fighting a barn fire on July 9, 1929, was struck across the dorsolumbar junction by a falling timber. He fell, developed a paraplegia of six hours' duration, and was referred to the Hospital by Dr. D. H. Anderson for a roentgenographic examination. Thereafter the patient suffered from pain in the back which was relieved when he assumed the recumbent posture.

The past history is significant. The patient, six feet and three inches tall, at fourteen years of age was a shoe machine operator, bending over a machine ten hours a day, during which time he developed a "bowed back". He worked at this occupation for ten years and then volunteered for service at the outbreak of the World War. Upon his return from overseas duty, his family noticed a marked lessening of the kyphosis, which, however, recurred upon his resuming his former occupation.

Roentgenographic examinations were made on several occasions during the subsequent three years, with no appreciable change in the findings. The films showed a diffuse nuclear prolapse, involving many vertebrae on one or both surfaces; distinct narrowing of the intervertebral spaces, especially anteriorly; wedging of the bodies; and increased irregular calcification of the body interfaces with sharpening of the anterior corners (Fig. 2). Scheuermann's notch was not preserved.

On June 14, 1932, the patient chose a violent death and an autopsy was performed. The only findings of interest pertain to the vertebrae, which fulfill in every detail the pre-autopsy opinion (Fig. 3).

We believe that this patient had osteochondritis of the cartilaginous plate, of a very severe grade; whether or not he had dorsal epiphysitis, we are unwilling to state. His history is very suggestive except that we have no history of pain during adolescence. This may be the end of the life cycle of the disease which Scheuermann described in adolescents, and the disease which Schmorl found at autopsy. We do not know, but, if this is so, the importance of the osteochondritis far outweighs the epiphysitis. Although the autopsy completes the case in so far as the spine is concerned, we deplore the failure to examine the cord for injury.

CASE 3. G. R., male, aged fourteen years, fell from a cherry tree on September 20, 1931, and was brought to the Hospital complaining of pain in the left wrist and back. Before the accident the child had been perfectly well. Roentgenograms showed a Colles' fracture of the left wrist, a well developed vertebral epiphysitis (Scheuermann type), and probably a compression fracture of the dorsal surface of the eighth dorsal vertebra. Accurate diagnosis here was difficult because of the high degree of wedging, due to the coincident epiphyseal disease. Physical examination showed a well developed kyphosis at the point of suspected fracture.

Roentgenograms of the spine showed Scheuermann's notches on the twelfth dorsal vertebra and on the first and second lumbar vertebrae, and marked nuclear prolapses of long standing. There seemed to be a mild degree of osteoporosis of all the vertebral bodies (Fig. 4).

Six months later, after hyperextension in a body cast, the patient was reexamined, but there was no apparent change, and no relief of vertebral pain.

We believe this to be a case of vertebral epiphysitis with severe osteochondritis. The fall from the cherry tree accentuated an already existing spinal disease.

In conclusion, let it be understood that we are making a differentiation upon the occurrence of disease in two places,—one, the diaphyseal side of the epiphyseal line on the interfaces of the vertebral bodies; two, the prolapse of the nucleus pulposus, due to pathology of the cartilaginous plate, probably an osteochondritis. From the medicolegal point of view it is important to note the onset of symptoms which were not amenable to treatment following a definite trauma.

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## A NEW METHOD OF ARTHRODESIS OF THE SHOULDER JOINT, INCORPORATING THE CONTROL OF THE SCAPULA

BY A. LEO BRETT, M.D., BOSTON, MASSACHUSETTS

The difficulty of establishing ankylosis of the shoulder joint in the position of election has been experienced by all operators. In the majority of cases, the loss of position is due to the surgeon's inability to control the action of the scapula until bony union has taken place. Unless this structure is definitely immobilized following the arthrodesis, protective spasm, as afforded by the *teres major* and *teres minor* and to some degree by the *supraspinatus* and *infraspinatus*, causes the scapula to draw outward toward the humerus, thus making the scapulohumeral angle more acute than is desired. Extrinsic means alone, as provided by the fixation methods in use, cannot be relied upon to check the activity of the scapula, regardless of whether the arm is held continuously in the position of abduction.

Confronted with the problem of devising a means that would definitely assure immobilization of the scapula, the author has sought by the use of a bone graft to establish stability. The method evolved assures maintenance of position until union is solid. It also has the additional advantage of allowing early mobilization. Thus far, the technique has been used in two cases, and the results have been functionally perfect.

### LITERATURE

A survey of the methods of arthrodesis that have been introduced shows that the efforts of operators have been directed primarily toward establishing bony union between the humeral head and the glenoid (Albert<sup>1</sup>, Karewski<sup>2</sup>, Bothezat<sup>3</sup>, Hoffa<sup>4</sup>, Tubby<sup>5</sup>, Vulpius<sup>6</sup>). To the pioneers in the field of arthrodesis, the achievement of this end—the first prerequisite of a successful arthrodesis—also presented a great deal of difficulty. Within recent years, through the introduction of bone grafts, the problem of securing solid fixation has been practically solved, and a union may be obtained that allows good voluntary control of the arm (Vulpius<sup>6</sup>, Albee<sup>7</sup>, Key<sup>8</sup>, Straub<sup>9</sup>, Immelmann<sup>10</sup>). But, while the range of abduction obtained may be sufficient to allow the patient to raise his hand even to his mouth, the motion is not so complete as is desirable, or as may be established under the method of treatment that is here suggested. None of the methods in use provides for fixation of the scapula other than by extrinsic means, which are not reliable, and hence the favorable angle for arthrodesis is lost, with a consequent limitation of voluntary abduction.

The author's experience with the customary methods of treatment has not, on the whole, given gratifying results, in spite of the exercise of



FIG. 1

N. D. End result, seven years after arthrodesis, showing the range of voluntary abduction.

great care in carrying out the details of technique. The patients have obtained a perfectly solid union with good voluntary control, but there has always been a certain limitation of abduction, due to inability to maintain the position of election. Figures 1 and 2 show clearly the loss of position that occurs following an arthrodesis by one of the customary operative methods in use. The patient had had infantile paralysis. Arthrodesis of the joint was attempted by breaking down the acromion process, denuding of cartilage the under surface of the acromion and the articular surfaces, and establishing contact. The resulting union was



FIG. 2

N. D. Roentgenogram, taken one year after arthrodesis, showing excellent bony union, but the loss of elective position.

solid, and the patient has good voluntary function sufficient for a useful arm, but there is not a complete range of abduction, due to the acute scapulohumeral angle.

#### INDICATIONS

Arthrodesis of the shoulder joint has a wide field of applicability. The procedure is indicated in complete and permanent paralysis of the deltoid, usually due to infantile paralysis. As in all cases of infantile paralysis in which surgical intervention is considered, the cases must be carefully selected for operation, and the presence of a useful hand is essential. Arthrodesis should never be advised until at least one year has elapsed from the onset of the disease; for recovery of power, either complete or in part, is always possible within this period.

In tuberculosis of the shoulder joint, especially in the adolescent or the adult, arthrodesis is indicated not only to arrest the activity of the bacillus, but also to relieve pain and restore function. It should be performed as soon as the definite diagnosis is made, providing the age and physical condition of the patient present no contraindications.

Arthrodesis is a more effective means of restoring health and function to the tuberculous joint than are other methods of treatment. Heliotherapy, for instance, may provide an excellent functional result, but it is not unusual to see a joint treated in this manner recover with a painful fibrous union, or with a bony union in poor position that allows only a limited range of motion. Arthrodesis also has certain advantages over excision in that it restores a functional power that is more nearly normal, it fits the member for the resumption of hard labor, if necessary, and it ensures relief from pain.

Arthrodesis is also indicated occasionally in chronic painful conditions of the shoulder joint, due to an arthritic process, or resulting from a severely comminuted fracture of the head of the humerus or of the glenoid. In the case of the laborer, fixation offers the most satisfactory means of relief, as the function that would be restored by other operative procedures—such as an arthroplasty or a reconstruction operation—might continue to be accompanied by pain under heavy use.

Other indications for arthrodesis are presented occasionally in an obstetrical paralysis with a partial dislocation of the joint, in traumatic brachial paralysis, and in a recurrent dislocation of the shoulder joint, when all other recognized stabilizing operations fail, and when the patient is prevented by the disability from resuming his occupation.

#### AGE FOR ARTHRODESIS

An arthrodesis of the shoulder joint may be successfully performed at any time after eight years of age. This minimum age limit must be respected, for before this age ossification has not progressed sufficiently to assure the success of the procedure. In young patients, the years between twelve and fifteen are undoubtedly best for stiffening the shoul-



der, as operation can be performed at these ages without interfering with the growth of the arm. The procedure has been used successfully by the author in several cases of infantile paralysis where the patients were between the ages of eight and ten years, and the results have justified the operation in that the restoration of function stimulated the growth.

#### POSITION FOR ARTHRODESIS

The position most advantageous for fixation of the humerus to the scapula is that which allows the compensatory action of the scapulothoracic musculature to be utilized completely. When the extremity is ankylosed in such position, the patient can voluntarily abduct his arm to above the level of his head; he can lower it to the proximity of his side; and he can rotate it backward and forward to a limited extent. The loss of a certain amount of rotation, which must necessarily occur on account of the anatomical position of the scapula, is the one drawback to arthrodesis, but, fortunately, the limited degree of rotation made possible by the loose muscular suspension of the scapula is sufficient for practical purposes. In the adult, the best position for arthrodesis is approximately seventy degrees of abduction and approximately twenty degrees of anterior flexion. In the child, the position of optimum function is about eighty degrees of abduction.

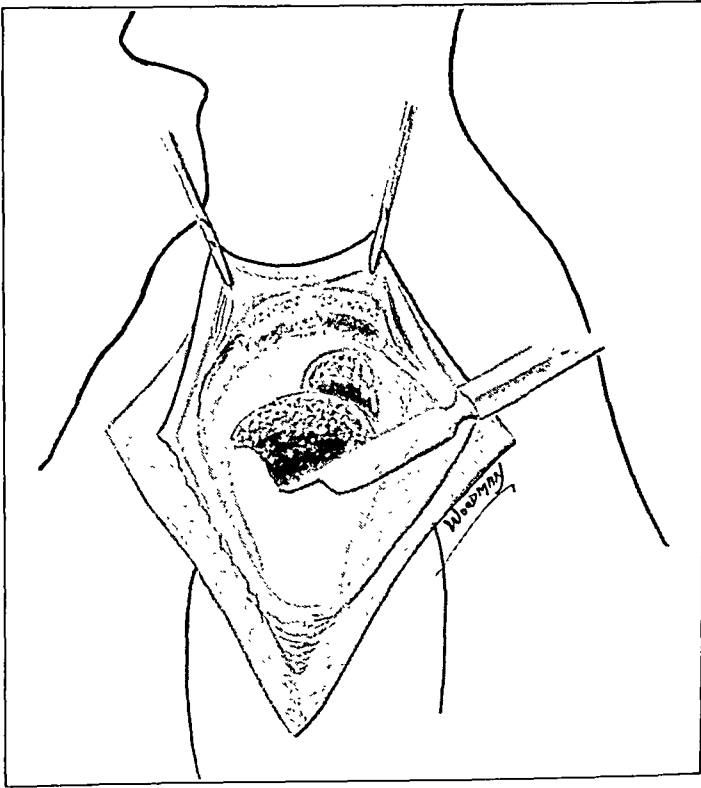


FIG. 3

The joint surfaces and under surface of the acromion have been denuded of cartilage, and the acromion has been broken down preparatory to being brought into contact with the head of the humerus.

#### OPERATIVE TECHNIQUE

When the case is one in which contractures of the arm would prevent placing the extremity in proper position following the operation, the contractures must first be overcome by maintaining the arm in abduction in a plaster bandage for a sufficient period preceding surgical intervention.

A curved skin incision over the shoulder joint, or a straight incision beginning high above the acromion and running downward

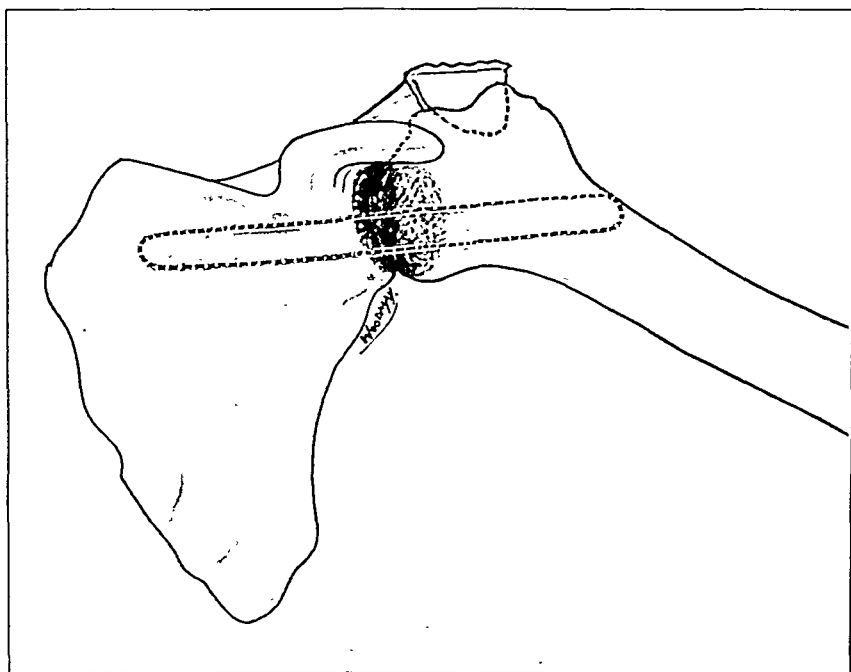


FIG. 4

Showing the massive tibial graft in place.

parallel to the shaft of the humerus, may be used. The fascia is incised, and the tissues and muscles are freed and retracted as required. The capsule is split longitudinally, and, with a periosteal elevator, dissected back from its attachment on the anatomical neck of the humerus, except for the portion about the posterior third of the bone. The head is then forced out of the glenoid by rotating the arm outward.

The surfaces of the head, glenoid, and under side of the acromion process are carefully denuded of cartilage, so that the cancellous bony structures are exposed. Care must be taken to remove the cartilage on the peripheral edges of the glenoid in order that bony contact can be established with the head (Fig. 3).

With an assistant holding the arm in the accepted position for arthrodesis—that is, in seventy to eighty degrees of abduction and in twenty to thirty degrees of forward flexion—a drill hole about one-quarter of an inch in size is bored from just below the greater tuberosity through the humeral head in line with the center of the glenoid, then through the glenoid, and finally into the spine of the scapula, until the end of the drill is palpable in the outer scapular musculature. In the adult, this hole is sometimes enlarged to three-eighths of an inch by means of a larger drill.

The bone graft is then removed from the tibia. The author prefers to wait until the bed is prepared before removing the graft, to be assured of a fresh transplant. A massive graft, three-eighths of an inch in width,



FIG. 5

Case 1. M. L. Roentgenogram before arthrodesis, showing flail joint with considerable deformity of humeral head. Note wire leading from acromion to head, used in previous attempt at arthrodesis.

merus, it may be removed with a rongeur (Fig. 4).

The acromion process, which has been previously denuded of cartilage, is broken down in the manner of a greenstick fracture, so that it will present the broadest surface possible in relation to the head of the humerus. It is then fixed to the head by means of stay sutures of chromic catgut No. 3, or kangaroo tendon, which is passed through the drill holes already made. This contact helps to establish stability and to hold the head against the glenoid. The capsule is sutured down on the humerus for further stability. The musculature and skin are sutured. A well fitting plaster spica, embracing the shoulder and chest down to the umbilicus, and extending from the neck to the fingers, is applied, with the shoulder in the position of seventy to eighty degrees of abduction and twenty to thirty degrees forward of the frontal plane, as the case may indicate.

The plaster spica remains intact for at least two months. At the end of that time the upper half is removed to permit baking and massage,

and varying in length from three to five inches, depending on the size of the bone structure of the patient and his age, is taken. The operator then narrows down the graft with a rongeur, shaping it so that it will fit snugly.

With the arm still held in the position of election, a hole is drilled through the upper border of the head and glenoid, and the humerus is tied in place with kangaroo tendon.

The graft is now driven through the head, through the glenoid, and out through the spine of the scapula, until it is palpable at the end of the drill hole. If any of the graft protrudes from the hu-

and the patient is instructed to begin raising and lowering his arm voluntarily. This after-treatment is continued for a period of two weeks or a month, depending upon the evidence of union as shown in the roentgenogram. At the end of this time, the entire spica may be removed, and exercises given daily to produce hypertrophy of the scapular muscles.

#### CASE REPORTS

CASE 1. M. L., male, aged twenty years, when first seen in July, 1930, had a perfectly flail right shoulder as the result of infantile paralysis in childhood. The deltoid had no power; the biceps and triceps were weak. The power in the forearm and scapular muscles was good. Five years previously, an arthrodesis by means of wiring had been unsuccessfully attempted by a surgeon in Greece.

On July 31, 1930, an arthrodesis was performed according to the technique described. The wire, when removed from the acromion, broke into several pieces (Fig. 5). The head of the humerus was misshapen, and the glenoid was buried in scar tissue.

Four months after the arthrodesis, a roentgenogram showed solid union with the arm in approximately seventy-five degrees of abduction and twenty degrees of anterior



FIG. 6

Case 1. M. L. Roentgenogram, taken four months after arthrodesis, showing bony union with arm in approximately seventy-five degrees of abduction and twenty degrees of anterior flexion. Note graft in place, with beginning of absorption.

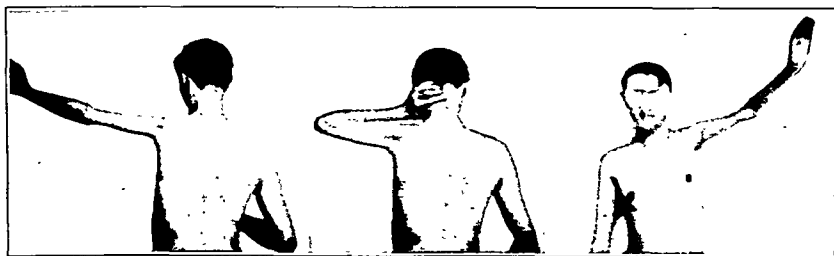


FIG. 7

Case 1. M. L. End result, two and one-half years after arthrodesis, showing range of voluntary abduction.

flexion (Fig. 6). By January, 1931, the patient could raise his arm above a right angle, a movement that he had not been able to carry out since early childhood.

In January, 1933, two and one-half years after the operation, the arm functioned perfectly. The patient was able to put his hand on top of his head, to lower it to within a few degrees of his side, and to do laborious work (Fig. 7).

It is interesting to compare the result pictured in Figures 1 and 2 with those of this case in which a more complete range of abduction was obtained, in spite of the fact that the humerus was malformed and part of the humeral head had to be removed.

**CASE 2.** R. D., male, aged eighteen years, when first seen in April, 1927, complained of pain, soreness, and the inability to raise his left arm. The symptoms had been of three years' duration and dated back to a questionable injury received while playing football. There had been a gradual increase of the symptoms and during the three months previous to examination they had been considerably worse. On examination, the shoulder was found to be considerably atrophied, and all motions were markedly limited and protected by spasm. The roentgenogram showed evidence of joint destruction. The diagnosis of a tuberculous shoulder was made.

On May 10, 1927, an arthrodesis was attempted by one of the customary methods. The joint surfaces and the under surface of the acromion were denuded of cartilage, the parts fitted together and tied in position, and a bone screw passed down through the acromion into the head for further fixation. The recovery was uneventful, and a roentgenogram, taken in September, 1927, showed that the position of the arm was holding fairly well, and the bone screw absorbing.

During the next few months it was found that the patient could not discard his brace because of the mobility of the joint. When, on March 19, 1928, there still remained a few degrees of motion, although apparently there was fibrous union at the acromion process, it was decided to attempt another arthrodesis.

On April 12, 1928, the operation using the massive tibial graft was performed. In addition to using this graft, another step was taken to assure arthrodesis in this case in

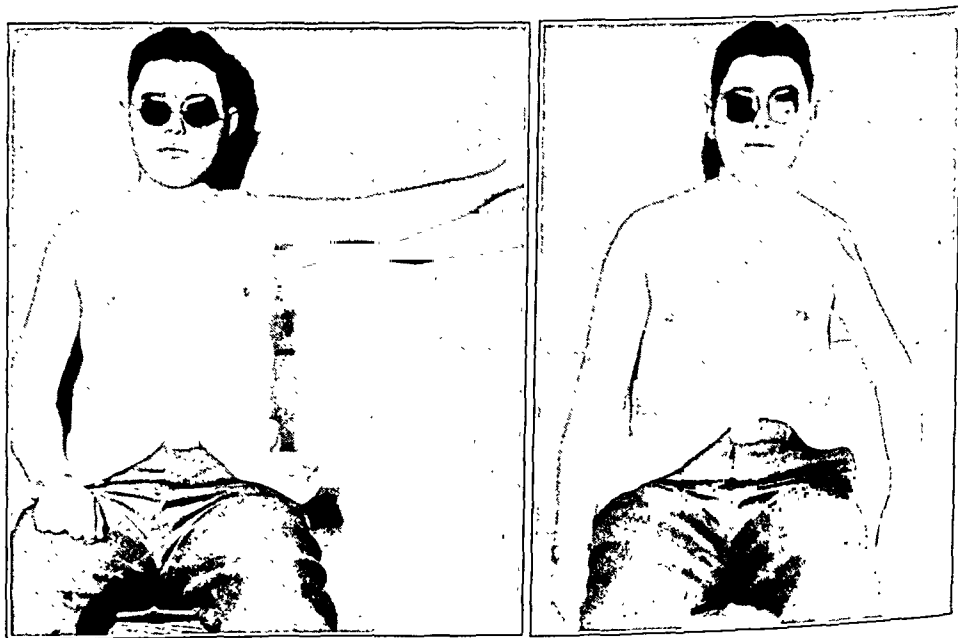


FIG. 8

Case 2. R. D. End result, five years following second arthrodesis, showing excellent range of voluntary function.

which a previous attempt to fix the arm had failed. A Y-shaped periosteal graft was laid from the acromion to the head and shaft, each branch of the Y extending down over the head to the shaft where it was tucked in subperiosteally.

In February, 1929, the patient could voluntarily abduct his arm to 100 degrees and extend it forward to forty-five degrees, and within a few months he was able to resume his occupation as a baggageman. In January, 1933, nearly five years after the operation, the functional result was perfect (Fig. 8).

#### CONCLUSION

The type of arthrodesis that has been described not only assures good bony union, but also establishes complete fixation of the scapula in relation to the humerus. It has the additional advantage of establishing arthrodesis in a shorter period than is possible under the general methods in use; instead of a six months' period of immobilization, the patient may use his arm at the end of the third or fourth month.

The results obtained in the two cases in which the technique has been carried out have been a source of satisfaction to both the patient and the operator. A complete range of motion has been obtained, and the patients have been able to resume laborious work within a period of four months following the arthrodesis.

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# PREVENTION OF SUBLUXATION OF THE HUMERAL HEAD FOLLOWING OPERATIONS FOR ARTHRODESIS OF THE SHOULDER JOINT

BY GEORGE WAGONER, M.D., HAVERFORD, PENNSYLVANIA

*From the University of Pennsylvania, Philadelphia*

Dislocation of the humerus following operations for arthrodesis of the shoulder joint is a frequent occurrence. This postoperative catastrophe has arisen regardless of the type of arthrodesing procedure employed. To prevent it numerous methods have been devised, none of which has proven entirely satisfactory.

A modification is presented which promises to prevent humeral subluxation. It may be used in any of the standard operations for arthrodesis of the shoulder joint. The procedure of choice for arthrodesis is supplemented by a Nicola operation.

The long head of the biceps is sectioned at the distal end of the bicipital groove. The proximal end of the tendon is passed through a hole drilled from the lateral surface of the greater tuberosity through the long axis of the humeral head. The articular surfaces of the humeral head and glenoid are denuded of cartilage. The periosteum is resected from the tip of the acromion if this structure is to be used. The arm is placed in the classical position for fusion and the head of the humerus firmly contacted with such of the scapular structures as desired. That portion of the long head of the biceps passing through the drill hole in the head of the humerus is drawn taut. It is securely sutured to the distal end of the same tendon and to adjacent deep tissues in such a manner as to permanently maintain the tautness.

The above procedure has been used in several cases. It has been found to aid in maintaining coaptation of the raw-bone surfaces and to prevent subluxation of the humeral head.

## ARTHROPLASTY OF THE ELBOW \*

BY FRED H. ALBEE, M.D., SC.D., LL.D., F.A.C.S., NEW YORK, N. Y.

*Professor of Orthopaedic Surgery, Columbia University*

The patient with a stiff joint seeks operation to attain mobility and usefulness of the joint. It remains for the surgeon to realize that a reasonable degree of stability and muscular control is quite as important as mobility to satisfactory postoperative function, and to the ultimate contentment of the patient. To gain the latter at the expense of the former is to bring down a storm of criticism on one's head. A flail joint can be just as annoying as a stiff joint. It is, indeed, the difficulty of gaining at the same time mobility, stability, and active muscular control of motion in both flexion and extension which has placed arthroplastic operations in a class by themselves, requiring the keenest prevision and surgical judgment, and the highest technical skill.

Although stability at the elbow may not be as important as in a weight-bearing joint, a fair degree of stability is most essential to certain movements, particularly active control in extension. A man cannot wield a hammer or saw with a flail elbow, the extension of which depends on gravity; and lifting a weight above the head, whether it be books or bricks, is an important movement in everyone's daily routine, depending quite as much on stability and control at the elbow as on mobility.

In a remade elbow, the most certain way of gaining the desired stability and muscle control is by providing a sufficiently long bone lever for the triceps to pull upon. In this way, active extension is restored in full as a balancing influence or antagonistic pull to that of the biceps and other muscles. Active flexion is present in all movable elbows following arthroplasty; whereas active extension is rarely restored because of inadequate olecranon leverage. The original technique which is presented herewith possesses not only the advantage of restoring olecranon leverage with active extension and stability, but it also affords the freest access to modeling the joint (Figs. 1-A and 1-B).

### AUTHOR'S TECHNIQUE

The approach is by a skin incision on the posterior aspect of the joint, beginning just over the tip of the olecranon and extending proximally about four inches directly over the superficial posterior crest of the ulna. The skin and subcutaneous tissue are dissected laterally. The olecranon and about three and one-half inches of the posterior crest of the ulna are developed, care being taken not to disturb either the attachment of the

\* Read before the American Orthopaedic Association at Washington, D. C., May 9, 1933.



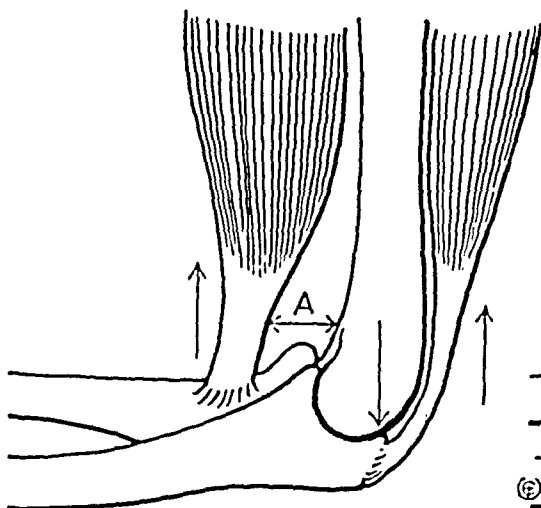


FIG. 1-A

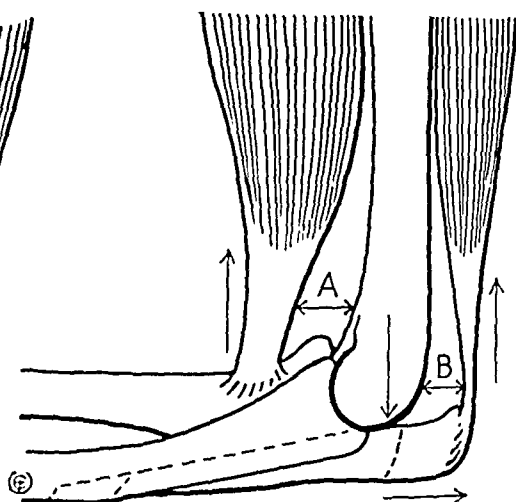


FIG. 1-B

Diagrams showing provision for leverage action of triceps muscle by sliding olecranon process posteriorly: *A* indicates leverage for action of biceps; *B*, for action of triceps.

triceps muscle or the ulnar nerve. In some instances, when infection or severe trauma has destroyed or shortened the olecranon process, the triceps muscle is developed to its bony insertion at the posterior surface of the ankylosed joint; this, with its bony attachment as a part of the larger bone fragment, is later turned back as follows.

With a single motor saw, held at an oblique angle, cuts are made in the proximal portion of the ulna, converging both in cross section and longitudinally, and extending distally from the olecranon process or insertion of the triceps muscle about three and one-half inches. The fragment thus formed, including the proposed new olecranon process, is then turned

upward with the triceps muscle attached to its proximal end as a hinge. Thus, complete exposure is obtained for modeling the new joint from the posterior and lateral aspects.

The soft parts to the side are then dissected from the bone and the ulnar nerve is either meticulously avoided or dissected out and held laterally by a tape.

Sufficient bone is then removed to

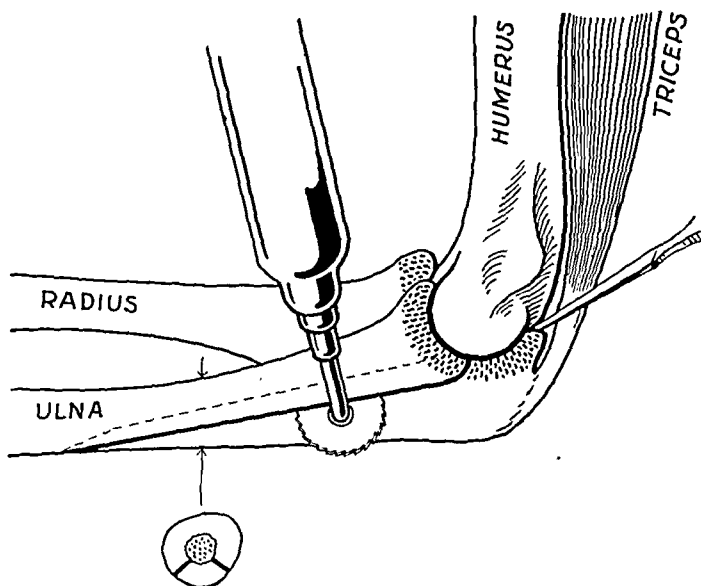


FIG. 2

Diagram showing converging saw cuts on upper posterior surface of ulna, including whole olecranon process.

permit free flexion and extension of the ulna and radius upon the condyles of the humerus, and to allow adequate space to receive the fascia-fat graft, which will line the new joint. Care should be taken to so mold the joint surfaces that a free and smooth range of motion is allowed. This should be tested out by putting the arm through the full range of flexion and extension.

All roughness and irregularities are next removed from the freshly cut bone surfaces of the humerus, radius, and ulna, and the bone surfaces are still further smoothed and possible future bleeding prevented by repeated blows of a mallet against the large end of a bone drift or some other rounded instrument, held against the bone surfaces.

As a still further hemostatic influence, the newly formed elbow is packed with a hot saline compress and held temporarily in position by means of towel clamps, while a graft of fascia and fat of sufficient size to cover the newly formed joint surfaces on the humerus, ulna, and radius is obtained from the outer surface of the thigh. It is important that the fat should be sufficient in amount to fill in the bony interspaces, but it should not result in too much tension upon the closure stitches.

With the arm flexed, this aponeurotic tissue is sutured in place, care being taken that every vestige of raw-bone surface is covered on both elements of the newly made joint. The arm is then extended, the olecranon-ulna fragment turned downward into its groove and slid far enough proximally and posteriorly to furnish a long posterior lever for the full extension and stabilizing action of the triceps muscle (Figs. 2 and 3).

Drill holes are then made opposite each other in the ulnar end of the sliding olecranon-ulna graft, and in the gutter in the ulna itself. At the olecranon end of the graft, a single drill hole is made in the ulna only, just lateral to the gutter. Medium-sized kangaroo tendon is drawn through the holes in graft and gutter at the ulnar end by means of the cervix needle, and the graft securely tied in place. At the upper end, the

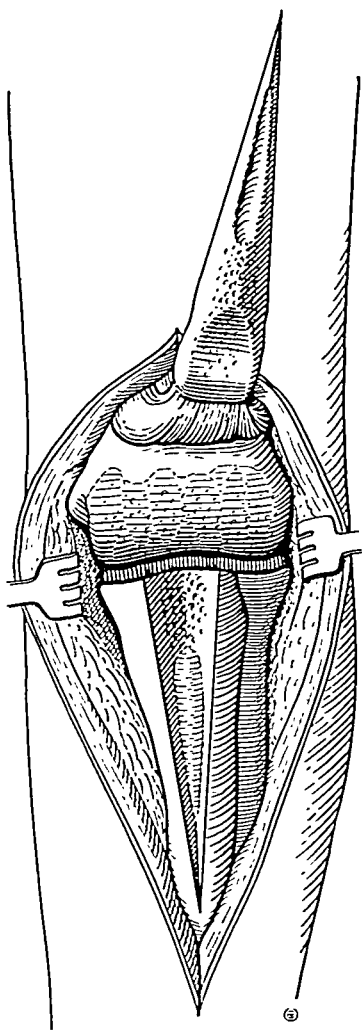


FIG. 3

Diagram of olecranon-ulna fragment turned upward, showing wide exposure afforded.

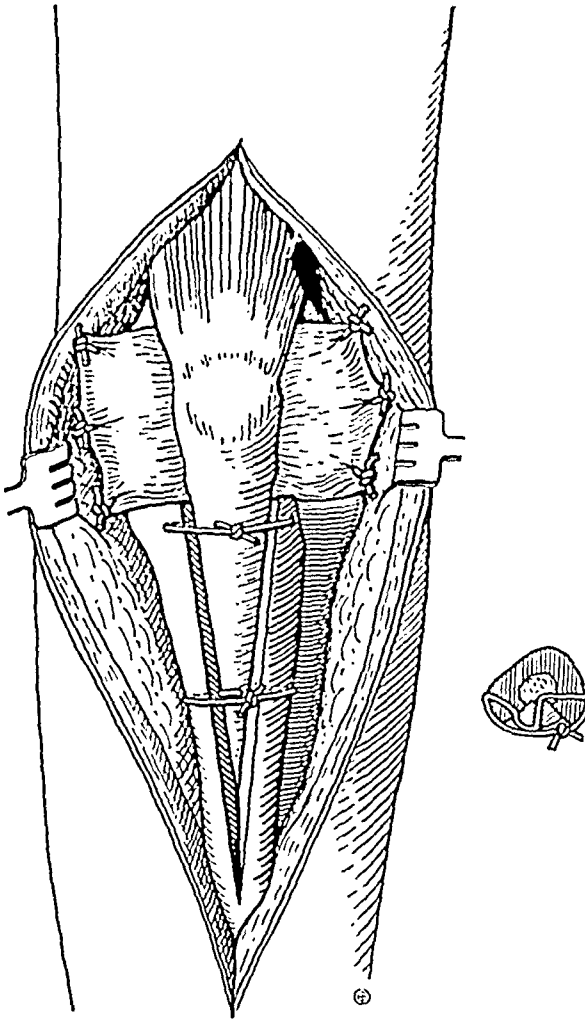


FIG. 4

Diagram showing fascia-fat graft sutured in place and olecranon replaced in its gutter.

fear displacement of the olecranon-ulna graft, for, because of its length and the inlay method of insertion, the union of the fascia and soft parts drawn over the graft at the time of closing the wound will prevent such displacement even before bony union has taken place. Therefore, one need not wait for solid bony union before beginning active and passive motion and physiotherapy, as would be necessary if the olecranon had been merely severed.

In regard to a telescoping effect produced by the sliding olecranon-ulna graft, it might be said that the same effect could be secured by displacing the ulna with the radius posteriorly upon the humerus at the newly formed joint; but it should be realized that this would necessarily be at the expense of the leverage action of the radius anterior to the joint and would not allow the biceps and other muscles to retain their full power of flexion. Flexion, by action of the biceps on the anterior arm of the lever, and extension, by the antagonistic action of the triceps on the newly formed olecranon, are both preserved by the method used.

tendon is passed through the hole in the ulna and simply tied around the graft (Figs. 4 and 5).

The subcutaneous tissues are then approximated with great care, with No. 1 chromic catgut, over the fat and fascia graft as well as the sliding bone graft and ulna, and the skin is closed by continuous suture with No. 0 plain catgut. The suture holes and the line of suture are thoroughly puddled with a three and one-half per cent. tincture of iodine, and the excess wiped off. A generous dressing of gauze and sterile cotton and a plaster-of-Paris cast are applied from the base of the fingers to the axilla, with the arm in the flexed position. The cast is left on for a period of three weeks. After its removal, massage and manual manipulation should be begun immediately and continued daily for a period of at least one month. One need not

On the other hand, if, following arthroplasty, the leverage action of the olecranon process is lost or diminished in length—as is usually the case—slight or no leverage action is afforded to force the arm into extension by triceps-muscle action.

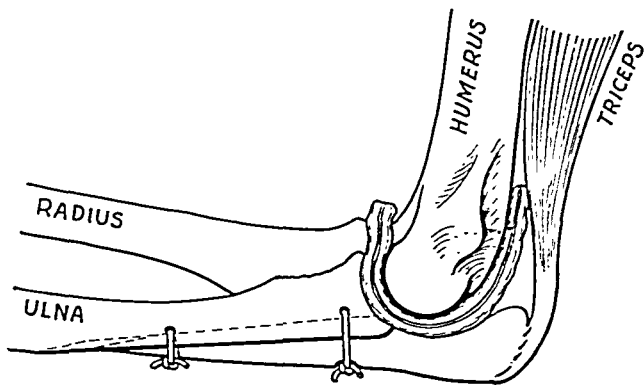


FIG. 5

Lateral view, showing newly formed joint with an adequate olecranon lever.

The forearm extends passively, merely by its own weight, and can do so only when the arm is in certain positions.

The ample approach afforded is also very important because, even with the aid of the x-ray, one cannot be sure what complications may be encountered at operation.

#### THE SOURCE OF THE APONEUROTIC FLAP

Some surgeons take the flap to line the joint from the arm instead of from the thigh. The preference for doing a large and more difficult operation locally rather than opening up a secondary field is the old bugaboo which has been such a stumbling-block. Flaps taken from the arm are not nearly as satisfactory as those from the thigh, for the fascia is not sufficiently dense, the fat is not thick enough, and it is very hard to get a flap large enough to cover both elements of the newly formed joint. A pedicle is an absolute delusion and most unnecessary: first, because a free fascia-fat graft will become vascularized in a short time and remain viable; and, second, because whatever blood supply there happens to be in the pedicle is very likely to serve no purpose in that it becomes occluded either from the pressure of the twist which is exerted upon the pedicle or from traumatization.

#### INDICATIONS FOR ARTHROPLASTY

It is universally agreed that the elbow is a particularly favorable joint for arthroplasty. However, before advising operation, one must always consider the origin of the ankylosis (traumatic or infectious), its type (fibrous or bony), the age and social status of the patient, and the condition of the bone, musculature, and skin.

Bone atrophy, or osteoporosis, adds to the difficulties of operation. The important muscles which control the joint should be free from extensive infectious or traumatic scarring.

Arthroplasty is most successfully performed in patients between the

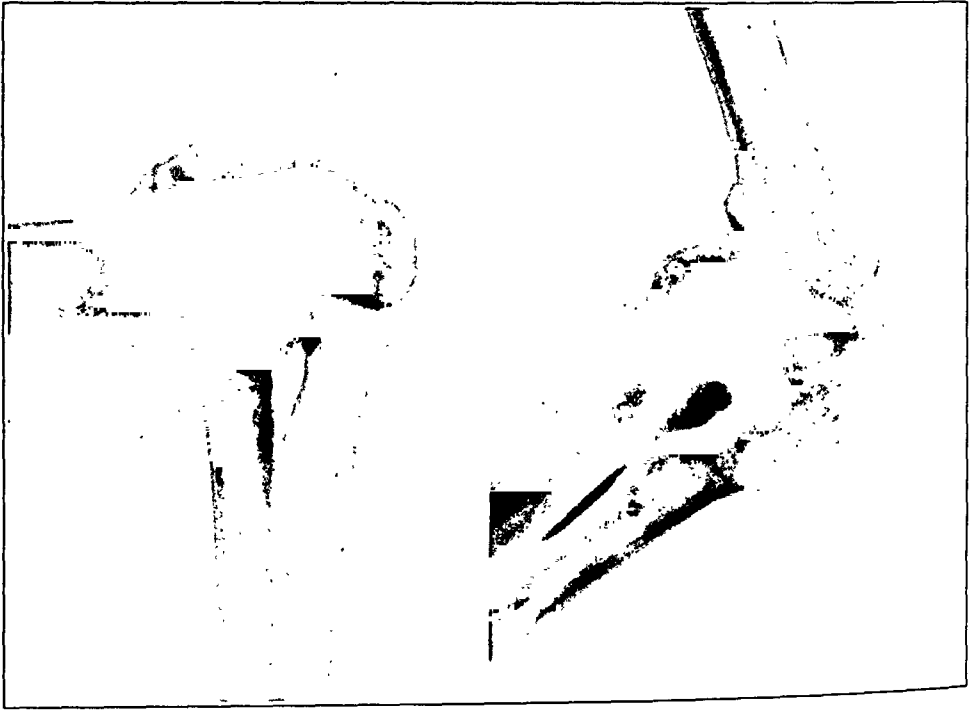


FIG. 6-A

Case J. J. S. Preoperative roentgenogram, showing complete bony ankylosis of many years' duration, resulting from multiple arthritis. An arthroplasty four years previously had resulted in complete failure and reankylosis. Complete loss of olecranon process is shown.

ages of twenty and forty years. It should never be undertaken until epiphyseal growth has nearly ceased.

The patient should be in excellent general health. Routine checking of all possible sources of infection is a wise preoperative precaution. MacAusland reports cases in which he encountered serious postoperative complications,—in one instance, because of secondary wound sepsis from an abscessed tooth; and, in another, from an acute fulminating abscess of the appendix. The presence of eburnated bone, extending on either side

of the joint, lessens the chances of success, but does not definitely contraindicate arthroplasty.

In general, however, one may say that the contraindications to arthroplasty of the elbow are few. In view of the great inconvenience and awkwardness resulting from a stiff elbow, the patient should be given the benefit of mobility (Figs. 6-A and 6-B).

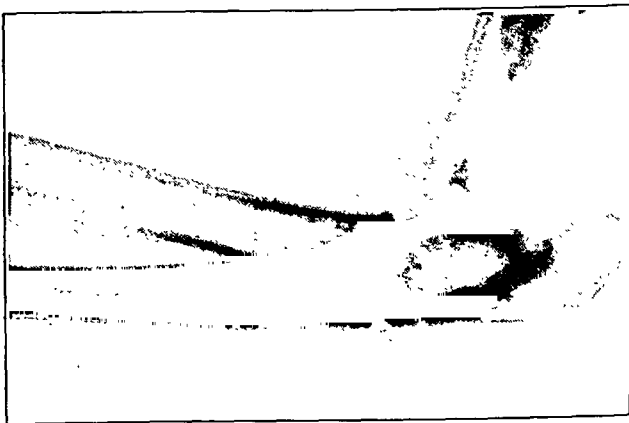


FIG. 6-B

Case J. J. S. Postoperative roentgenogram, showing reconstructed olecranon process.

## SUMMARY

The advantages of the method herewith proposed may be summarized as follows:

1. The approach gives the freest exposure possible without jeopardizing important structures. This point cannot be too highly emphasized because the very success of the operation depends upon the most meticulous care in the removal of all peripheral bone (especially in front of the joint) as well as the suture of the interposed fascia-fat graft.

2. It enables the surgeon to remove sufficient bone to insure complete freedom of motion without jeopardizing stability. Stability is brought about by the antagonistic pull of the flexors and extensors upon a lever whose fulcrum comes at the newly formed joint, the posterior arm of which (the olecranon) is long enough to allow sufficient antagonistic action of the triceps to bring this about.

3. Early immobilization without danger of separation or non-union of the ulnar parts is made possible by this use of the long, sliding, inlay olecranon-ulna graft, to which the insertion of the triceps is undisturbed, and the accurate mortise fit of this graft into its proper gutter.

# THE RATIONAL TREATMENT OF BONE TUBERCULOSIS\*

BY CHARLES K. PETTER, M.D., OAK TERRACE, MINNESOTA

*Department of Surgery, University of Minnesota and Glen Lake Sanatorium, Oak Terrace, Minnesota*

We are all cognizant of the facts that tuberculous disease of bone is the result of hematogenous implantation of tubercle bacilli in that structure, and that these bacilli are carried from a bronchial gland, mesenteric node, or pulmonary focus. Therefore, when one sees clinical tuberculosis of a given joint, he cannot tell, off hand, how many latent foci exist in other joints or organs; for there certainly is no good reason to believe that during a period of bacillaemia, a few organisms are going to lodge in the fine end arteries of a single bone and miss all the other joints, the kidneys, skin, and lymph nodes. In fact, reviewing a series of our extrapulmonary cases, we find multiple lesions in fifty-five per cent., while an active pulmonary disease accompanies the bone lesions in eighty-five per cent. With this as a background, it is only logical to conclude that adequate treatment of orthopaedic tuberculosis should begin with the general hygienic measures so well established in the management of pulmonary tuberculosis,—i.e., bed rest, good food, and fresh air; to which is added a most valuable adjunct,—namely, heliotherapy.

During such a period of conservative therapy one can determine the presence or absence of other foci, active or latent, and afford the patient an opportunity to build up his resistance to the disease, reducing likelihood of complicating lesions and the ultimate period of disability.

There are really three schools of therapy in bone tuberculosis. First, the heliotherapists, who feel that solar therapy and prolonged general rest bring about better results than the surgeon's knife. Such a régime requires long periods of hospitalization. In our country this is economically bad, except in children, and does not as a rule produce bony ankylosis. One point in favor of the treatment advocated by this group, however, is the fact that all lesions in all parts of the body are benefited by the régime while the particular lesion in question is being treated.

The second group believe in ambulant treatment with brace or cast, or else they immediately perform an arthrodesis, lay in a bone graft, or amputate a member, without examining more of the patient than the particular portion causing local symptoms. The primary period of disability is short and the fixation secure, for the particular lesion operated upon; but how many of these cases subsequently require hospitalization for another focus which was active but neglected at the time of the original operation? A good many of the ambulatory cases ultimately come to more radical surgery and longer disability than would have been necessary, had a régime of general rest therapy been instituted immediately. And further, if adequate preoperative and postoperative treatment is not given, patients with bone grafts as splints show progres-

\*Read at the Annual Meeting of the Minnesota Orthopaedic Society, Rochester, Minnesota, May 22, 1933.

sion of the disease while the bone graft "takes", resulting in inadequate fixation, exacerbation of symptoms, and repeated periods of disability.

Since it is our job to return disabled individuals to industry as rapidly and in as good condition as possible, a therapeutic régime should be employed which would shorten the total disability period, give some assurance against reactivation, and result in a low "disability rating".

Therefore, as the third school, let us employ the following general hygienic measures, plus heliotherapy, using those orthopaedic appliances which are indicated until the optimum conditions obtain for surgical intervention:

1. An improvement of the general condition of the patient,
2. Demonstration of patient's ability to combat the disease,
3. A quiescence of the destructive process in the bone, and
4. A favorable state (quiescence of activity) of other tuberculous foci.

Whether or not all tuberculous joints should be ankylosed is a matter of judgment, depending upon the sex, age, and occupation of the patient. It is certain however that in order to produce a permanent result, *all weight-bearing joints should be ankylosed*, the method of fixation or ankylosis being a matter of choice with the surgeon. While the bone graft is becoming fixed or the arthrodesed joint fusing, the conservative or general therapy is resumed until it is deemed advisable to begin graduated activity,—i.e., until the tuberculous disease is considered inactive or arrested.

In a series of bone cases at Glen Lake Sanatorium treated entirely without surgery the average number of hospital days was 1115, while in a series of cases treated by general therapy *plus surgery* the period of hospitalization was reduced to 682 days. Follow-up records in the first group showed recurrence or reactivation in twenty per cent., occurring within the first two years after discharge, while in the second series, followed from one to three years after operation, the figure was two per cent.

A further series of cases, treated surgically without preliminary observation and allowed up in three to six months, then admitted to Glen Lake Sanatorium with reactivation, slipping bone grafts, or new lesions, required longer periods of hospital care than did the same type of case treated by the régime outlined.

#### CONCLUSIONS

1. Since tuberculosis is a disease which may involve any part of the body, we must treat the whole individual in the best interests of that individual, no matter in what structure the disease is manifest clinically.

2. Treatment should be governed by the combined abilities of both the orthopaedic surgeon and the specialist in tuberculosis.

3. Proper surgical procedures at the right time, preceded and followed by the more conservative general therapy, afford better and more lasting results than conservative measures alone, or surgery without adequate preoperative observation.

4. Our present therapeutic régime has reduced hospital days from 1115 to 682 and recurrences in the first two years from twenty to two per cent.



# CONGENITAL ABSENCE OF THE ODONTOID PROCESS RESULTING IN DISLOCATION OF THE ATLAS ON THE AXIS

BY SUMNER MEADE ROBERTS, M.D., BOSTON, MASSACHUSETTS

On September 4, 1931, a young man, twenty years of age, came to the emergency ward of the Massachusetts General Hospital complaining of pain in his neck. The onset of symptoms had been sudden and had occurred the day previous when he had been "bridging" in a gymnasium. This meant that, lying on the gymnasium mat face uppermost, he had lifted his body off the mat by arching his back until his weight was supported only by his feet and his hyperextended head. In this position he was slowly moving his feet so that they described a circle with his head as a pivot. He suddenly felt something snap in his neck at the base of his skull and collapsed on the mat with severe pain in his neck. There was no loss of consciousness and no impairment of sensation or function in his extremities. He went home alone, but came to the hospital the next day because the pain in his neck still persisted, though to a lesser degree.

Physical examination showed a well developed and muscular young man who held his head turned about twenty degrees to the right of the mid-line and tipped very slightly to the left. There was moderate tenderness on pressure over the spinous process of the axis and slight tenderness laterally on both sides at the same level. Visual examination of the posterior nasopharynx revealed no abnormality. All neck motions were slightly painful and were limited by muscle spasm. He could not rotate his chin to the left of the mid-line. Other motions were correspondingly restricted. Passive motion of the occiput on the atlas was nearly normal, but all other passive motions were limited by muscle spasm. A diagnosis of a forward dislocation of the left articular facet of the atlas on the axis was made.

The roentgenographic examination confirmed the clinical diagnosis, except that the dislocation was backward on the right, instead of forward on the left, and also revealed the reason for it. The patient had no odontoid process (Fig. 1). The odontoid had apparently failed to develop. The spot where the base of the odontoid normally would be appeared as a smooth ridge with a slight sulcus on either side at the inner margins of the articular processes.

The patient was put to bed on a Bradford frame and five pounds of head traction were applied. Roentgenograms taken three days later showed the dislocation to be reduced (Fig. 2). A molded leather collar was made and fitted and he was discharged from the hospital one month after entry. The question that arose at the time of discharge was: Was this boy constantly in danger of another dislocation, a dislocation which might readily be fatal? The answer was probably in the affirmative. Any trivial injury, such as a sudden unguarded movement, might dislocate an unstable neck of this sort. This danger was explained to the patient and a stabilizing operation advised. Operation was refused, however.

This man was seen again one year later, during which time no untoward accident had occurred. He had not played football, but had played basketball regularly. His neck was symptom-free and all motions were normal. The danger he was running was once more explained to him and operation advised, but he again refused.

## SUMMARY

An unusual congenital abnormality, absence of the odontoid process, is described. This deformity resulted in a backward dislocation of the atlas on the axis. The dislocation was reduced, but, without a stabilizing operation, it may readily recur and such a recurrence may conceivably be fatal.

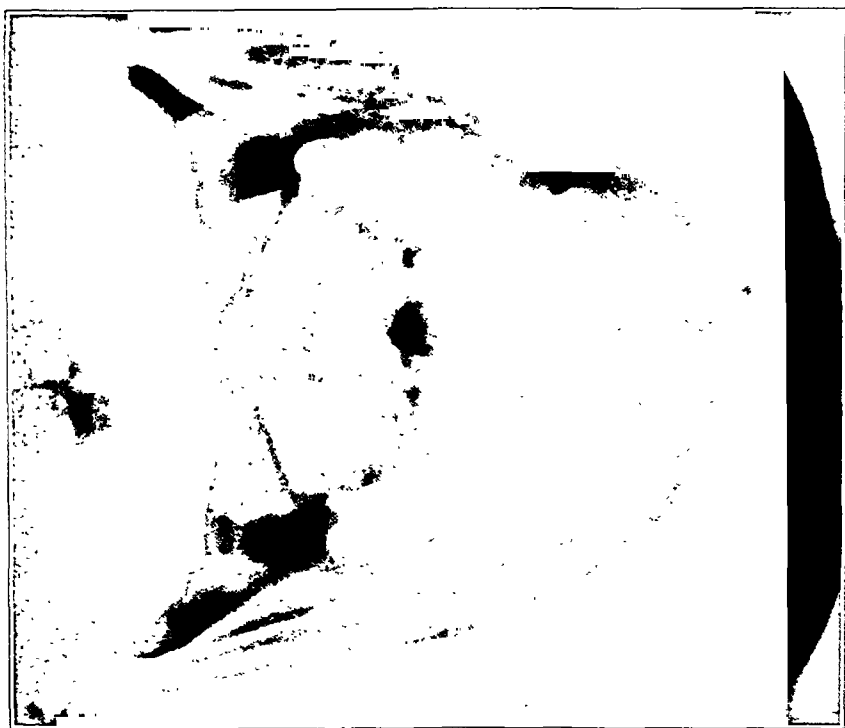


FIG. 2

Roentgenogram after reduction. Congenital absence of the odontoid is clearly shown.

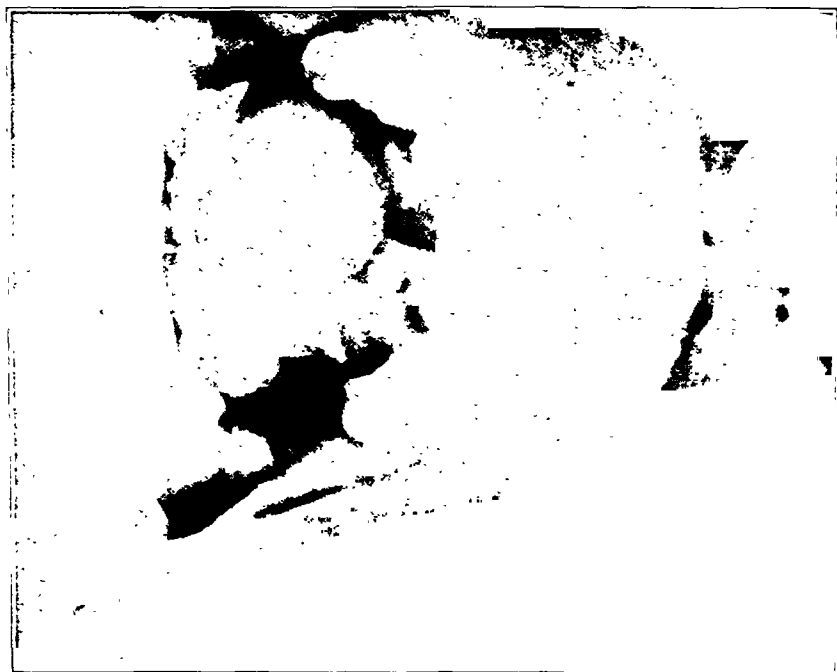


FIG. 1

Dislocation of atlas on axis. Roentgenogram before reduction.

# OSTEOPOIKILOSIS

## A CASE REPORT

BY HUGH JETER, M.D., AND CHAS. L. MCGEHEE, M.D.,  
OKLAHOMA CITY, OKLAHOMA

*Surgical Pathological Department, State University Hospital*

Cases of "osteopoikilosis" or "osteopathia condensans", apparently a variant of marble bone, have only occasionally been reported. We are able to find only nineteen such cases in the literature and, therefore, consider the following report justifiable.

T. N., white male, aged thirty-seven years, World War veteran, and a welder by occupation, was admitted to the Soldiers' Ward of the University Hospital, September 10, 1932, complaining of a skin eruption. The Dermatological Department made a diagnosis of tinea versicolor and administered appropriate treatment, with satisfactory improvement. The family and previous history were unimportant, except that the patient had had a shrapnel wound of the right shoulder with a resulting slight impairment of function. The roentgenogram of the shoulder revealed particles of shrapnel, and, in addition, scattered, small, dense areas about the metaphysis and epiphysis of the humerus. When a request for the roentgenograms of other bones was made, the patient volunteered the information that the same condition existed fourteen years previously while in service,—physicians had noticed "spots" in his bones, and many pictures had been taken. The patient was permitted to see the films and he considered the condition about the same as in 1918. An attempt was made by the author to look up his service record through the Veterans Bureau but information was refused.

Physical examination revealed no deformities, or abnormalities, except the skin lesions. He appeared hale and hearty. Pulse rate during his hospital period of thirty-eight days ranged slightly higher than normal, temperature normal, and blood pressure 110/65. Three separate specimens of urine were negative. The blood counts were normal; Wassermann and Kline tests, negative. Blood chemistry findings were as follows: non-protein nitrogen, 27 milligrams per 100 cubic centimeters; urea, 13 milligrams; uric acid, 5.6 milligrams; creatinin, 1.3 milligrams; sugar, 84.2 milligrams; blood calcium, 9.9 milligrams; blood phosphorus, 2.7 milligrams; total protein, 10.9 per cent.; albumin, 7.1 per cent.; and globulin, 3.8 per cent. The basal metabolic rate was minus 9.2 per cent.

The roentgenographic examination of the skeletal system showed multiple areas of increased density of bone, most numerous about the metaphyses and in the epiphyses of the bones of the feet, hands, arms, and legs, with a few such areas in the pelvic bones and scapulae. The bones of the spine, ribs, and skull showed no evidence of such changes. The areas of density were somewhat irregular in outline, but roughly round, fairly well circumscribed, and ranged from one-half to ten millimeters in diameter.

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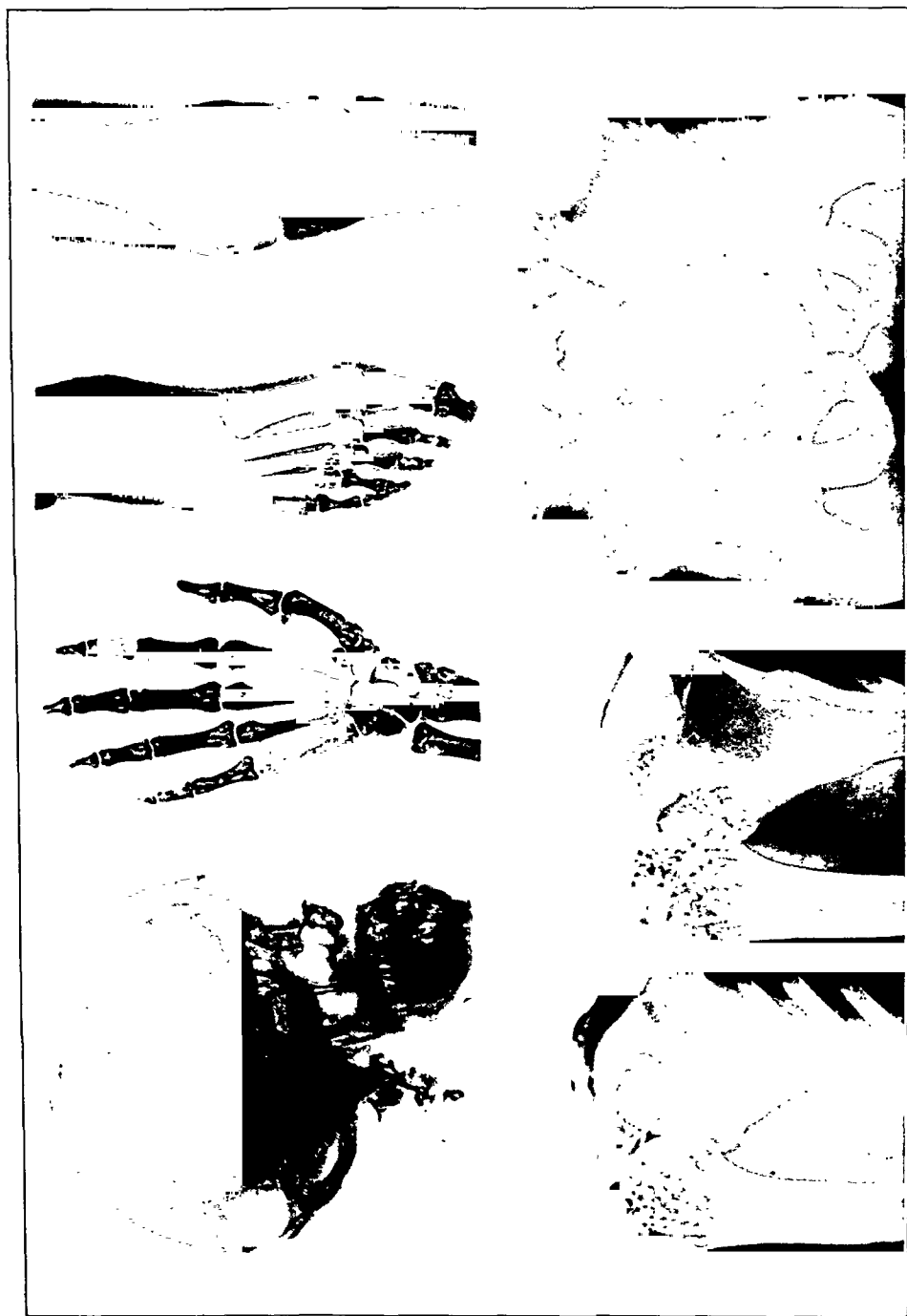


Fig. 1

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## THE SMITH-LOWE SPLINT

BY ETHAN H. SMITH, M.D., SAN FRANCISCO, CALIFORNIA

Several years ago the value of the well known Hodgen's splint was demonstrated to the author in a fracture of the lower half of the femur into the knee joint, with three large hematomata on the outer side of the thigh, but difficulty was experienced in preventing toe-drop. In view of this case, as well as later experiences, and with the aid of suggestions from Dr. Frank A. Lowe, this splint has been modified to meet this defect.

The splint as now constructed has two side bars, bent at an angle so as to semiflex the knee, thus relaxing all muscles of the hip, thigh, and lower leg. A half hoop or bail is so set in sliding sleeves that the length may be changed to adapt it to the individual patient. A central bail for support of the side bars and a hinged bail at the top are set into the side bars, and these side bars are inserted into tubular bars, allowing adjustment of the thigh portion to any necessary length. The hinges at the top permit either side to be extended higher than its opposite, so that the top of the outer bar may extend higher than the inner, and may alternate so as to accommodate either the right or the left leg.

By combining traction with suspension, many fractures of the leg may be easily treated by this splint. Skin traction is obtained by means of a moleskin plaster and fulfills all requirements, although skeletal traction may be used if desired. For fractures of the femur, including those of the neck of the femur, traction in two directions is necessary,—one pulling in the direction of the axis of the shaft of the femur, and the other below the foot in the axis of the leg. Pads are inserted between the bars and the leg or thigh to prevent lateral displacement.

The bail below the foot is wound with a bandage to bring the metatarsal region against the sole of the foot, and to prevent toe-drop as well as rotation of the foot.

The splint can be applied without anaesthetic when the patient is reasonable. It also helps to keep the bed sanitary and facilitates the use of the bedpan.



FIG. 1

Case 1. Second fracture before reduction.



FIG. 2

Case 1. Second fracture after reduction.

The trunk can be raised and lowered without disturbing the fracture, thus guarding against pulmonary complications.

#### CASE REPORTS

CASE 1. Mrs. J. N., aged seventy-nine years. Fracture of the neck of the femur at the junction of the head and neck. Reduction perfect; recovery complete; no anaesthetic. At the age of eighty-two

years the patient had a comminuted intertrochanteric fracture of the neck of the same femur (Fig. 1). Reduction, without anaesthetic, excellent, and splint applied. On the twenty-ninth day the patient had a second stroke of apoplexy and died. Pathological specimen of femur showed sufficient union so that fragments could not be moved upon each other by manipulation with the hand (Figs. 3 and 4).



FIG. 3

Case 1. Pathological specimen.

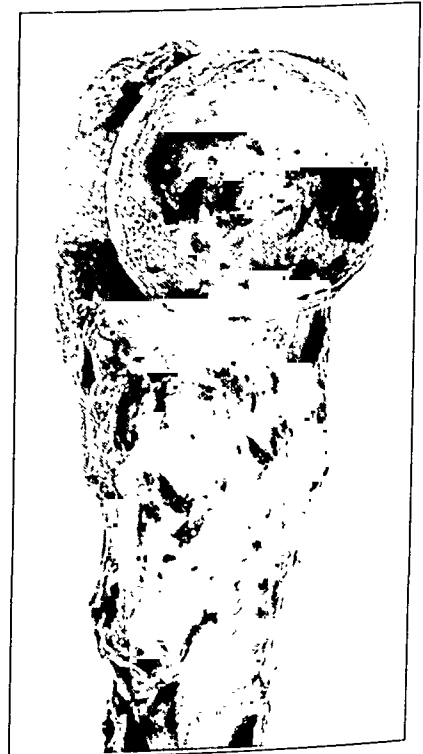


FIG. 4

Case 1. Pathological specimen, lateral view.

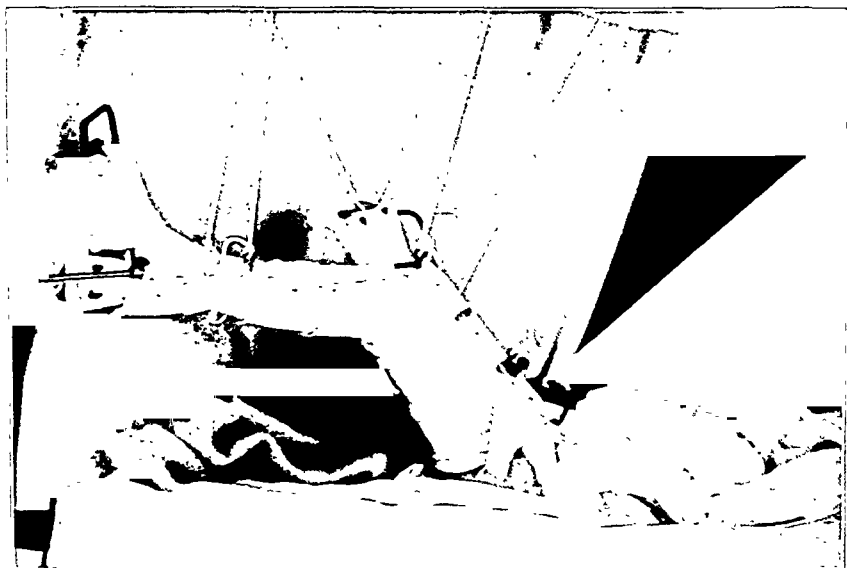


FIG. 5

Case 2. Showing application of splint.

CASE 2. G. R., girl, twelve years of age. Both femora fractured at junction of middle and upper thirds; comminuted fracture of neck of the left humerus. Treated by bilateral long spica for five weeks. Right femur united without deformity; non-union and overriding of fragments of left femur; malunion of humerus. After six weeks the patient came under the observation of the writer. Under anaesthesia the left femur was manipulated and the fracture reduced. The splint described was applied, and the patient made an uninterrupted recovery.

CASE 3. Mrs. R. M., aged sixty-two years. Comminuted fracture of neck of the left femur, and fracture within capsule of the joint. Patient a semi-invalid, with bronchial and cardiac disease. Splint applied without anaesthetic; good recovery; slight outward rotation, but no shortening.

CASE 4. Mr. E. L., aged sixty-one years. Struck by automobile and sustained a badly comminuted fracture of the head and three inches of shaft of the left tibia, and comminuted fracture and dislocation of head of left fibula. Splint applied under gas anaesthesia. Convalescence slow because of extent of fracture, but patient recovered with good knee joint,—no deformity and no shortening up to six months.



# PSEUDARTHROSIS OF THE TIBIA

## A CASE REPORT

BY CLARENCE A. RYAN, M.D., C.M., VANCOUVER, BRITISH COLUMBIA

This report is not offered with the view of adding anything new concerning the etiology or treatment of ununited fractures. The patient's history alone is of interest. The pseudarthrosis was discovered during the routine examination of the patient. His present complaint, a tenosynovitis of the ring finger of the left hand, does not bear any relation to the subject of this report and therefore will not be discussed.

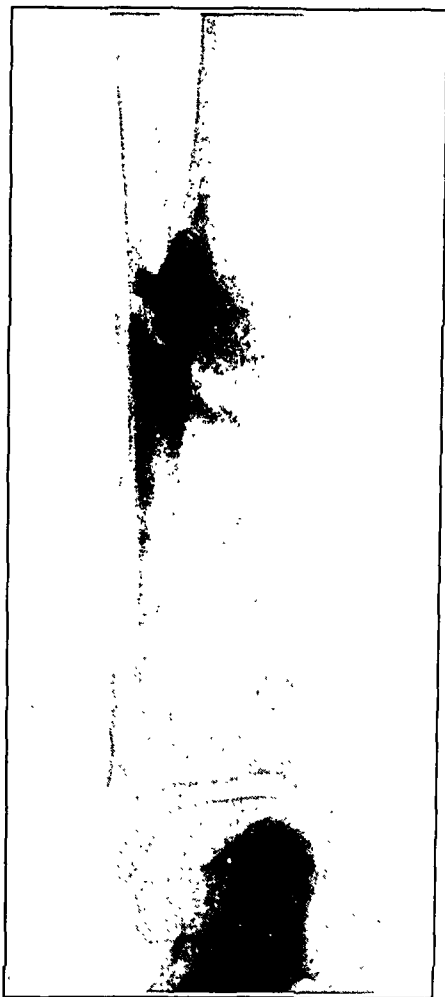


FIG. 1

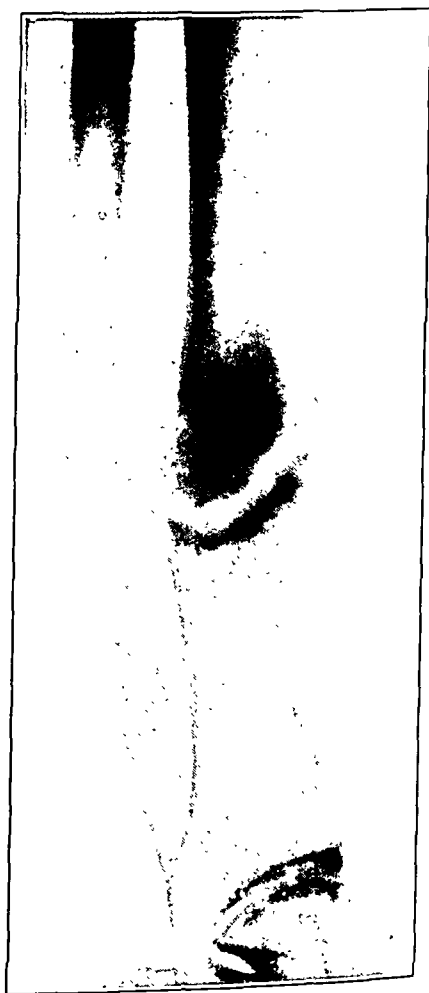


FIG. 2

Mr. B. cut his finger on a broken bottle in December 1932. Infection occurred and he was admitted to the hospital for treatment. Physical examination was negative except for the infected left hand, the left ankle, and the right lower leg. Examination of the left ankle showed what appeared to be a dislocated astragalus. Roentgenograms, however, did not show a dislocation of the astragalus, but what might be considered a forward displacement of the tarsus on the tibia. Examination of the

right lower leg showed an enlargement of about four inches above the malleoli (Fig. 1). The surface of the skin was elevated about three-eighths of an inch above the surrounding skin. The elevation was limited to the surface over the tibia. On palpation, motion could be felt in the tibial shaft. This motion was limited to about three degrees anteroposteriorly and to a lesser extent laterally. Crepitation could be heard on motion. The roentgenogram (Fig. 2) shows a modified ball and socket joint in the tibia. The ends of the bone comprising this joint are well covered by callus, but no attempt at union can be seen. There is an outward bowing of the fibula opposite the pseudarthrosis.

This patient is a cowboy, steer-dodger, and rodeo performer and his injury dates from 1921 when a horse which he was riding fell, throwing Mr. B. under him. Both bones of Mr. B's right leg were broken at the location of the pseudarthrosis, and both apparently healed.

In 1927, while riding in a wild horse race, the patient was again thrown and the same leg was broken in the same place. In this accident, his left ankle was dislocated (?). The fractured bones again healed but the dislocation was not reduced.

In 1929, while competing in a rodeo, he fell and fractured the right leg in the same place as the two former fractures had occurred. The accident occurred at four o'clock in the afternoon. A cast was applied at the hospital and the man returned to the rodeo and re-entered the competition an hour later. The following day he again took part in the round-up, although his right leg was in a cast. Three weeks after the accident, he removed the cast himself and did not consult a doctor until the time of his admittance to the Vancouver General Hospital for treatment of the infected hand, three years after his last fracture.

Mr. B states that he knew there was some motion in his leg at the site of the fracture, but, since it did not hinder him in any way or cause him any discomfort, he did not bother about it. He has continued his steer-dodging and broncho-busting without further injury. The only support to the leg is a high leather boot. His left ankle does not produce any disability, although the foot turns inward when more than ordinary weight or strain is placed upon it.

A review of the 1932 literature yields four references to pseudarthrosis of the leg. Campbell's report<sup>1</sup> is so complete as to etiology, blood chemistry, and treatment that no space will be occupied here with such discussion. No treatment was undertaken in this case since the patient did not wish it.

The author is indebted to Dr. H. H. Boucher for permission to publish this case.

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# SEBACEOUS CYST OF THE DISTAL PHALANX

BY FRANK E. CURTIS, M.D., AND CLARENCE I. OWEN, M.D.

DETROIT, MICHIGAN

The following case is reported because of the unusual character of the tumor.



FIG. 1

Anteroposterior roentgenogram before operation.

E. J. S., a male, twenty-nine years of age, was examined in December 1929 for an enlargement of the distal portion of the left mid-finger.

The patient stated that the swelling was first noticed in 1921, when the finger had a constant fever which was particularly noticeable after going into a warm room. He was examined for foci of infection and a tonsillectomy was done. This did not improve the condition of the finger. Later, tincture of iodine was several times injected into the finger, but the phalanx continued to increase in size and a constant, throbbing pain was present. In May 1924 the cyst was excised, but the size of the finger was only slightly reduced and the pain remained. Later, amputation of the finger at the mid-phalanx was advised as it was feared that the condition might become malignant.

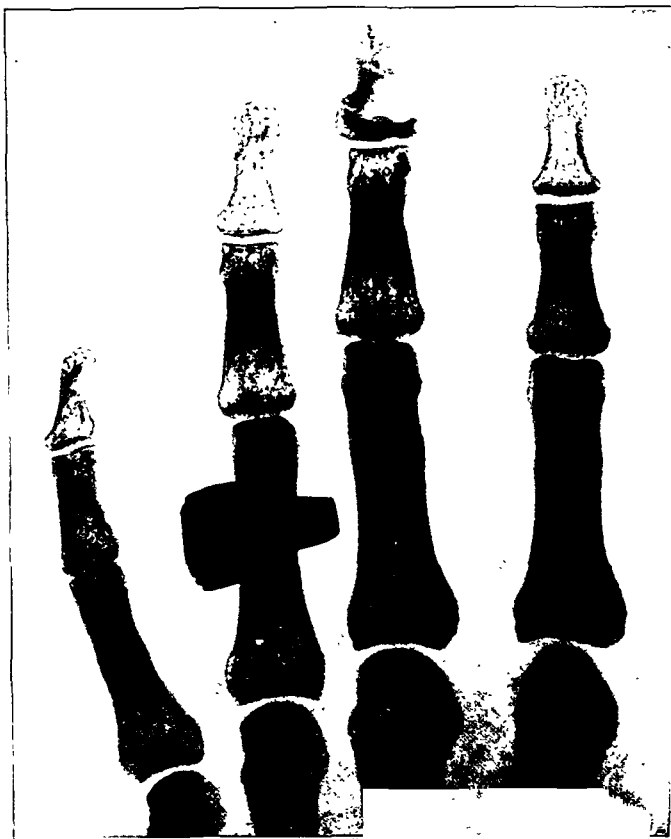


FIG. 2

Anteroposterior roentgenogram after operation.

In December 1929, examination showed the distal portion of the left mid-finger to be nearly twice its normal size and tender to touch. The convexity of the nail was increased. Roentgenograms showed two cystic areas in the terminal phalanx and removal was advised.

At operation the two cystic areas were found embedded in the partially destroyed terminal phalanx. The sacs were adherent to the bone and were of glistening, white, fibrous material inside of which was sebaceous material. The sacs were completely removed. A portion of the distal phalanx and fatty tissue was also removed for diagnostic purposes.

The microscopic examination made by Dr. Owen was as follows: "(1) The pieces of bone exhibit a small amount of callus formation and have attached to them some normal fibrous tissue; (2) the piece of soft tissue is composed of fibrous and areolar tissue and is infiltrated with a few small round and plasma cells; (3) the pieces of cyst wall are composed of markedly flattened, dense, fibrous tissue, relatively non-cellular and having a lining of flattened, stratified squamous epithelium. No glands are found in the wall."

The diagnosis was (1) Epidermoid cyst of the bone; (2) low-grade repair of the bone; (3) low-grade chronic inflammatory reaction of the soft tissue.

In the three and a half years since operation there has been no recurrence of the symptoms and the size of the finger has decreased. Prints of the roentgenograms before and after the operation are shown.



FIG. 3  
Lateral view after operation.

This cyst might be classified as epidermoid in nature, as only an epithelial lining was found in the wall, but, as sebaceous material was present in the cysts at operation, this is being reported as a sebaceous cyst. We can find a record of only one other such case, that reported by Dr. R. I. Harris.<sup>1</sup>

It is quite proper to regard this as an implantation tumor, although there is no previous history to support this fact.

1. HARRIS, R. I.: Sebaceous Cyst of Terminal Phalanx of Thumb. An Unusual Form of Bone Tumor. *J. Bone and Joint Surg.*, XII, 647, July 1930.

## THE OS EPIPYRAMIS: REPORT OF A CASE

BY ALBERT B. FERGUSON, M.D., NEW YORK, N. Y.

*Director of Roentgenology, New York Orthopaedic Dispensary and Hospital*

The os epipyramis is an element found on the dorsum of the hand between the lunate, triangular, and hamate bones. Dwight<sup>2</sup> says it is "a very rare bone. . . . It would naturally be mistaken for a fracture. Usually no trace of this element is to be found, but it may appear as a marking off of the dorsal distal radial angle of the cuneiform. . . . I have seen one case; but a doubtful one." It has been found as a separate bone in the human wrist by:

1. Pfizner, once; specimen.
2. Dwight, once; specimen; doubtful example.
3. Grumbach, three times; roentgenograms; two of these are not clearly separate entities.

4. Heimerzheim, once; roentgenogram; apparently an excellent example, but a tracing—not the roentgenogram—is reproduced.

This bone was not encountered by Pirie or Bogart in their studies of the accessory bones of the wrist.

The present case is reported because of the rarity of this bone and because it seems to be a clearer roentgenographic example than the cases noted above.

The patient is a boy, aged fifteen, with a fracture in the distal third of the left radius and ulna. The epipyramis is two millimeters in diameter, oval in shape, and situated in



FIG. 1  
Dr. Robert Bellig Library  
F. A. Medical College

the space between the left lunate, triangular, and hamate bones. It is well formed and there is no evidence of traumatism in its region.

Dwight's statement that this bone would naturally be mistaken for fracture seems unwarranted, as this is not a region where fracture is apt to be found unless traumatism is very extensive.

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# RUPTURE OF THE LONG HEAD OF THE BICEPS BRACHII

BY J. O. RANKIN, M.D., F.A.C.S., WHEELING, WEST VIRGINIA

*From the Department of Surgery, Wheeling Clinic*

Rupture of the long head of the biceps tendon is a comparatively unusual injury. In 1927 McKenna found eighty-one cases reported in the literature. To this number he added one case. A search of the literature since that time has revealed less than ten additional case reports. Most of these were described in foreign reports. Of the eighty-one cases that McKenna reported, only fifteen had gone to operation. The writer desires to report four additional cases, two of which came to operation and two in which operation was refused.

## CASE REPORTS

CASE 1. H. S., a white male, fifty-eight years of age, complained of pain in the right upper arm and inability to use the arm normally. He gave a history that two hours before examination, on January 14, 1930, he was helping some fellow workmen to lift a heavy metal vat with a bar, while at work in a foundry. He suddenly experienced a sharp pain in the region of the right shoulder and his arm seemed to "give way". Following this any attempted motion induced pain in this region. His past history revealed that he had always worked regularly and that he never had had any serious illness or injury.

Physical examination was negative except for the findings in the right arm. The first thing noticed on the arm was a peculiar spheroidal swelling just above the elbow joint anteriorly. This was intensified when the patient flexed the forearm. All motions could be carried out, but flexion and supination of the forearm induced severe pain. There was no evidence of subcutaneous ecchymosis. The most tender areas were just below the coracoid process and at the upper margin of the enlarged area in the lower arm. The forearm was normal.

Roentgenograms of the shoulder were negative. Blood Wassermann and urinalysis were negative.

A diagnosis of rupture of the long head of the biceps tendon was made and the patient was sent to the hospital for operation.

### *Operation:*

Tenoplasty, July 15, 1930. A longitudinal incision was made over the upper end of the belly of the muscle, in the anteromedial portion of the arm. When the deep fascia was opened, the tendon was found coiled up against the belly of the muscle. The end showed evidence of a recent rupture but was apparently normal otherwise. About one inch of the proximal end of the tendon was found protruding through the bicipital groove. The forearm was flexed and the ends sutured with interrupted chromic catgut.

The patient made an uneventful recovery and returned to his employment on September 15, 1930. He has had no further trouble.

CASE 2. C. O., a white male, American, aged sixty-five years, complained of pain in the left upper arm, and inability to move the arm. He gave a history that, on the preceding afternoon, March 10, 1932, while lifting and pushing on a heavy fly-wheel in a steel mill, he felt a sudden snap in the shoulder, which was followed by inability to move his arm in any direction without experiencing severe pain. The past history revealed that he had been a steel-mill worker for years. His family physician stated that he had had some arthritis in his shoulder joints.



Physical examination was negative except for some crepitation in the right shoulder joint and the injury in the left arm. The patient carried his arm very carefully in the flexed position. The typical spheroidal lump was seen just above the elbow joint anteriorly. It was intensified when further flexion was attempted. All motions of the shoulder joint produced pain, as did supination of the forearm. No ecchymosis was observed.

Roentgenograms revealed considerable hypertrophic osteo-arthritis around the edges of the glenoid fossa and at the acromioclavicular joint. Blood Wassermann and urinalysis were negative.

A diagnosis of rupture of the long head of the biceps tendon and osteo-arthritis of the shoulder joint was made.

#### *Operation:*

Tenoplasty, March 11, 1932. A long incision was made from just below the coracoid process down to the upper margin of the belly of the biceps muscle. The deep fascia was opened and the tendon was found coiled up against the proximal end of the muscle. The end was somewhat frayed. The proximal end could not be observed, as the rupture had occurred in the bicipital groove. As an end-to-end anastomosis was impossible, the end of the distal fragment was sutured to the origin of the short head with chromic catgut.

The patient's convalescence was perfectly normal except for some pain in the arthritic joint, which required physiotherapy. He returned to his work two months after the operation and has been completely well since that time.

CASE 3. F. S., a white male, forty years old, complained of pain in the region of the right shoulder joint. On November 20, 1931, the day before he came to the Clinic, he was cranking a car. During the act of pulling up on the crank, the motor back-fired, jerking his arm out in extension before he could let go of the crank. Simultaneously he felt a sudden sharp, severe pain in the shoulder, followed by inability to move the arm without experiencing pain. His past history was irrelevant to the present illness.



FIG. 1

Typical spherical deformity of belly of the biceps muscle after rupture of long head of the tendon.

The patient was carrying his arm in the sling his family physician had applied, which he stated was the most comfortable position. The typical spheroidal or bulbous swelling was noted above and anterior to the elbow joint and was intensified when further flexion was attempted. Marked tenderness was elicited over the bicipital groove and at the upper end of the muscle. Forced flexion and supination were exquisitely painful. All motions of the shoulder joint were normal. X-ray examination was not made.

The diagnosis was rupture of the long head of the biceps tendon. Operation was advised, but the patient refused to cooperate.

Recently the patient reported that he is free from pain and that, except for weakness upon flexion of the forearm, he has no untoward symptoms. The deformity in the lower arm has persisted. It is probable that eventually he will have practically normal power of flexion.

CASE 4. H. R., a white male, forty years of age, complained of a painful and swollen right arm upon admission to the hospital on July 11, 1924. On the morning of that day, he had been plowing with a tractor. While pulling up a steep hill, the tractor reared up and fell back on the patient, pinning him beneath it. The right arm was crushed.

X-ray examination revealed an oblique fracture of the humerus in the middle third, with marked displacement of the fragments. There was a large amount of swelling.

The arm was reduced as much as possible and packed in ice. Three days later a paralysis in the distribution of the radial nerve was noted. This, of course, necessitated open reduction and exploration of the radial nerve.

The wound healed by primary union and the fracture healed in three months. By this time all evidence of paralysis had disappeared. After all dressings were removed and motion started, it was discovered that the patient had the typical bulbous swelling of a rupture of the long head of the biceps tendon.

Repair of the tendon was advised, but the patient declined any further operative procedure. He has been examined at frequent intervals since the accident. The power of flexion has increased gradually until, at the present time, it is practically normal. The muscle has attached itself in the lower third of the humerus and has increased in size to compensate for the shortening, so that upon flexion it now stands out almost twice as far as the corresponding muscle of the left arm. At the end of a year all motions were normal and none produced pain. The normal strength of flexion, however, did not return for five years. Of course, a part of this delay in the return of normal function may have been induced by the fracture.

#### DISCUSSION

In all four of the cases reported, the patients gave a very definite history of trauma. Two were lifting very heavy objects, the third had his forearm suddenly jerked into extension while carrying out a flexion motion, and the fourth case was the result of direct trauma. In the case where rupture occurred in the bicipital groove there was evidence of some degenerative changes in the tendon, a result of the preexisting arthritis in the shoulder joint. Although a section was not removed for microscopic study, it certainly did not appear normal macroscopically.

All had the typical bulbous enlargement of the belly of the biceps muscle, which was considerably lower than the belly of the muscle on the opposite side. Pain was noted when flexion or supination was attempted and there was tenderness in the upper margin of the muscle.

The two patients who were operated upon made an uneventful recovery and returned to work. One of the two who were not operated

upon was observed for several years and now has about seventy-five per cent. return of function, although the deformity remains.

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# A SIMPLE METHOD FOR MAKING PLASTER CASTS OF FEET

BY EDWARD N. REED, M.D., SANTA MONICA, CALIFORNIA

For the making of accurately fitting arch supports, a plaster cast of the foot is necessary. The old method was to fill a pan with thick plaster cream, set the foot in this until the cream hardened, thereby securing a "negative", then to grease the negative and fill it with plaster cream, and, finally, to break off the outside mold, leaving an exact model of the foot in plaster-of-Paris.

A more rapid, simple, and less "mussy" method is the following:

Take a "hard-coated" plaster bandage, four, five, or six inches wide, depending on the height to which one wishes to carry the model up on the sides of the foot,—four inches for the "Boston" or the "spoon" type of plate, five or six inches if a "Whitman" type of plate is to be made. Cut from this bandage four lengths of the foot in question and lay them one on top of the other, as in making a molded splint. Powder the foot, dip the molded splint in water for a moment, lay it on the bottom of the foot, and rub it thoroughly against the foot while it is setting. The "fast" plaster will set in five or six minutes and can then be easily removed. We now have a thin shell model of the foot, which is both a positive and a negative.

To be sure, if used as a positive, it is a little larger than the actual foot, by reason of its one-eighth-inch thickness. But this thickness of the mold is just about equal to the thickness of the leather covering

of the finished support, plus the stocking of the wearer, so that the metal fitted over this cast will bear a correct relation to the foot when covered.

These models do not permit of "carving" before being sent to the plate-maker; but we have found that, if the cast is made with the foot held in corrected position, the plate will carry all the correction the wearer can stand, at least to begin with.



FIG. 1



FIG. 2

# LOOSE BODIES IN THE ELBOW JOINT

## AN UNUSUAL LOCATION AND FORM

BY RODNEY F. ATSATT, M.D., SANTA BARBARA, CALIFORNIA

### CASE REPORT

A male, aged twenty-two, was first seen on April 7, 1932, when he reported because "there was a loose piece" in his right elbow joint. He gave a history of injury during the previous football season, followed by a period of swelling and pain in the elbow. The pain, however, was not so severe as to cause much difficulty in ordinary use. When the swelling subsided, there was noticeable over the region of the radiohumeral joint a small mass half the size of a marble, which was freely movable within restricted limits. There was no history of locking or discomfort following the original injury.

Roentgenographic examination disclosed a loose body, one by one-half centimeter in size, lying adjacent to the lateral epicondyle. There was also, however, an unusual spherical, laminated shadow of bone density, one centimeter in diameter, in the supra-trochlear fossa, lying in a rounded notch, but apparently unattached (Figs. 1 and 2).

Prediction was made that at some future date the radial body would cause locking, and it did so on December 2, 1932, as shown in Figures 3 and 4. The patient presented himself with a locked elbow in 120 degrees of flexion. He consented to an operation and both bodies were removed. An uneventful convalescence ensued, with full return of function.

### DISCUSSION

Interest naturally centers on the spherical bone mass above the olecranon. This probably represents a small chip or bone from the tip of the olecranon, which has been constantly rolled over and over by a tangential impulse provided by the normal extension of the elbow. It



FIG. 1



FIG. 2

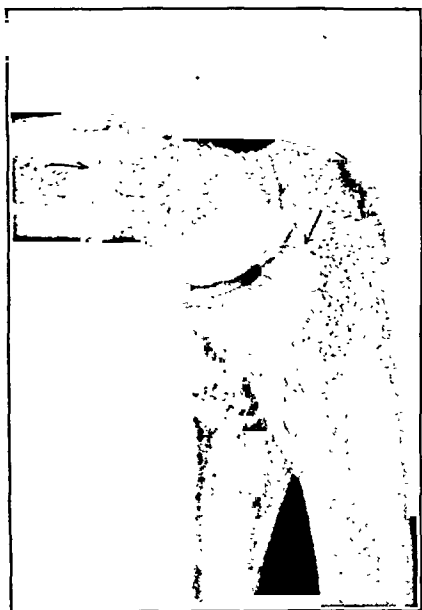


FIG. 3



FIG. 4

has thus grown into a perfect spherical form. Interestingly enough, at some time between the taking of Figures 2 and 4, this bone mass has been squeezed between the olecranon and the edge of the fossa with sufficient force to cause an eruptive fracture such as one would obtain by compressing a ripe orange.

The operative procedure was simple, but the case is reported because of the unique form and location of the supratrochlear loose body.

## A PROBABLE BIRTH FRACTURE OF THE NECK OF THE FEMUR

BY C. F. EIKENBARY, M.D., F.A.C.S., AND JOHN F. LECOCQ, M.D.  
SEATTLE, WASHINGTON

The following case is reported because of its extreme rarity.

A. S., aged eleven, came under our care because of a marked waddling gait which had been present from the time she began to walk. Outside of the fact that the peculiar waddling gait had been present from about the age of fifteen months, the history was entirely negative.

The examination showed that she was a very well developed girl, with two inches of shortening of the lower extremity. Her gait was quite typical of the unilateral, congenital dislocation of the hip. The head of the femur could not be felt, but, regardless of this, we felt that we were dealing with the usual case of unilateral dislocation. The roentgenogram, however, disclosed an extreme degree of coxa vara, as shown in Figure 1. After the roentgenogram had been taken, the mother produced another which had been taken six years earlier, when the child was five years old. This disclosed the condition shown in Figure 2. This picture certainly indicates an old fracture of the neck of the femur, which has partially healed, with a marked upward displacement of the shaft. The question immediately arises as to when this fracture occurred. There is no history of any trauma that could be responsible. The waddling gait,—that is, the unilateral



FIG. 1

A. S., aged eleven. Marked coxa vara as result of old fracture of the neck of the femur.

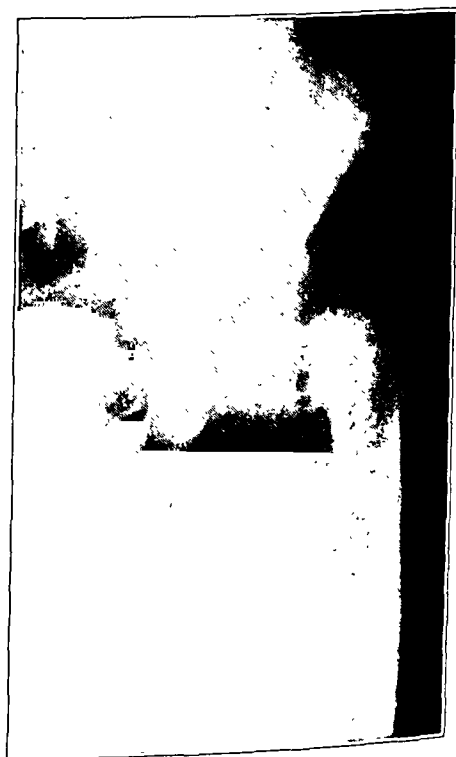


FIG. 2

A. S., aged five. Old fracture of the neck of the femur. Fracture evidently occurred at birth.

limp, had been present from the time the child began to walk. We must, therefore, assume that the fracture occurred some time before she was fifteen months of age. There was no trauma during this period, so we are practically forced to assume that the fracture occurred at birth. Intra-uterine fracture may be possible, but certainly not likely.

A cuneiform osteotomy was performed, with the result indicated in Figure 3. The child is greatly improved, but still has some of the waddling gait.

We have made a rather extensive search through medical literature to find reports of similar cases. At the time this report was written we had found none, and our investigation led us to conclude that this was the only such case on record. Since writing this account, however, we have been privileged to see a report by Dr. Zadek of New York City, who is recording a series of cases which are somewhat similar to this and which he is describing under the head of

"Congenital Coxa Vara". It is quite possible that this case falls in the same category as those reported by Dr. Zadek. However, in looking at the roentgenograms of the case which we are reporting, it seems to us that the appearance is that of an old fracture of the neck of the femur. Certainly Figure 2, the roentgenogram taken when the child was five years old, would seem to indicate that there had been a complete separation through the neck, with the formation of much new bone below the neck and extending down the shaft. While it is possible that we are entirely mistaken in regard to the actual diagnosis here, we feel that the case is of sufficient interest to warrant its report.



FIG. 3

A. S. Result following cuneiform osteotomy.



## ACUTE OSTEOMYELITIS OF THE PATELLA

BY FREDERICK CHRISTOPHER, M.D., F.A.C.S., EVANSTON, ILLINOIS  
*Associate Professor of Surgery, Northwestern University Medical School; Chief Surgeon,  
Evanston Hospital*

Acute osteomyelitis of the patella is exceedingly uncommon. In an original thesis from Toulouse in 1914, Chalaby<sup>1</sup> collected twenty-two cases from the literature. In 1917, apparently without knowledge of Chalaby's paper, Walther<sup>2</sup> reviewed ten cases from the literature and added two of his own from Lexer's clinic. Previously Röpke<sup>3</sup> had reported two cases from Jena during the period 1889 to 1904. In the case reported by Johansson<sup>4</sup> in 1919, the diagnosis eventually was made by x-ray and the patella was excised. In 1921, Mumford<sup>5</sup> reported a case which finally healed after sequestration.

The following case report is of interest because of the complicating suppurative arthritis.

W. deP., aged eight years, was admitted to the Evanston Hospital on June 23, 1932, following an automobile accident. At operation a ruptured spleen was removed; the convalescence was complicated by a double bronchopneumonia.

At the time of this accident an insignificant abrasion of the left knee was sustained. The knee gave the child occasional pain and there was swelling and limping during the summer. There was tenderness on palpation. X-ray of the knee was negative.

On September 29, 1932, a sequestrum, five-tenths by five-tenths by one-tenth centimeter, was removed from the wound.

On October 3, 1932, the joint was aspirated and a small draining sinus was curetted, but it did not heal. Culture of the joint showed staphylococcus albus.

On December 14, 1932, the sinus was opened up widely and a considerable necrotic portion of the patella was removed. During this operation the knee joint was invaded through the posterior wall of the patella. The leg was immobilized in a cast, and soon afterward walking was resumed and the boy seemed to be getting along nicely.

On January 1, 1933, the knee began to swell and become painful and the temperature rose to 102 degrees.

The patient was admitted to the Evanston Hospital on January 3, 1933. The following day necrotic and infected bone was curetted from the left patella. An opening in the patella, one-half inch in diameter, communicated directly with the knee joint, from which escaped a large quantity of purulent fluid. The joint was irrigated with hot saline containing mercurochrome and the opening drained by Penrose tubing. The following day an arthrotomy of the left knee joint was done. Two long incisions into the joint were made on each side of the patella. Considerable pus and grayish plaques of fibrinous exudate were encountered in the joint. Cultures showed hemolytic streptococcus. The joint was again irrigated with hot saline containing mercurochrome and the edges of the synovial membrane were tacked over toward the skin edges to insure drainage. The leg was placed in a Thomas splint with four pounds of traction.

The patient's course in the hospital was a stormy one, with a high septic temperature, a progressive secondary anaemia, and a marked amount of purulent drainage from the affected joint. The temperature frequently reached 104 degrees with wide septic swings. The pulse ranged between 120 and 180 for a great part of the time. The hemoglobin dropped from 71 per cent. to 47 per cent. on January 24, 1933, when the red blood count

was 2,740,000. On January 6, 1933, the white blood count reached 46,600. The wound formed a large excess of granulation tissue.

On January 20, 1933, under avertin anaesthesia, the leg was placed in a plaster cast with an opening at the knee for drainage. A whole blood transfusion of 350 cubic centimeters of blood was given on January 25, 1933, by the Scannell method.

Four weeks after admission, the patient was discharged from the hospital improved but still running some fever. The boy's general condition improved at home and he started walking. The cast was removed on March 15, 1933. On May 25, 1933, there was considerable motion in the knee joint, some swelling, and no pain. The boy walked with a slight limp and was greatly improved in general health. The wounds were practically healed. The x-ray examination showed some rarefaction and destruction of the patella, but the general contour was very satisfactory. On August 20, the function was 85 to 90 per cent. of normal.



FIG. 1

Acute osteomyelitis of the patella, appearing six months after initial injury.

The diagnosis of acute osteomyelitis of the patella is not always made. In the uncomplicated cases, without involvement of the knee joint, tenderness to pressure localized over the patella will be found. There may or may not have been a previous local skin injury. Johansson<sup>4</sup> points out as characteristic that "the knee is held in the extended position and that there is no indirect tenderness to pressure in the longitudinal direction of the leg". This author further states: "If, as is mostly the case, perforation takes place extra-articularly, the case will appear as a prepatellar-bursitis". In the more advanced cases x-ray examination will be of value.

Where the joint has become involved, the symptoms of the suppurative arthritis will predominate.

The treatment of uncomplicated cases consists of curetting away the infected bone, taking care not to open the joint. Spontaneous sequestration may occur. Where there is a suppurative arthritis a radical arthrotomy should be practised. Johansson<sup>4</sup> advised total extirpation of the patella in these cases. This latter procedure is also employed in chronic, healed cases where there is marked limitation of motion.

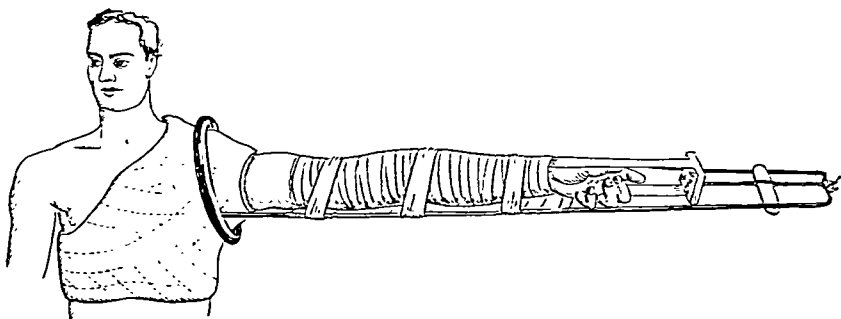
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# A PLASTER-OF-PARIS BUTTRESS FOR USE IN CASES OF FRACTURE OF THE HUMERUS TREATED BY MEANS OF TRACTION IN A THOMAS SPLINT \*

BY JOSEPH B. STENBUCK, M.D., F.A.C.S., NEW YORK, N. Y.

Treatment of fracture of the humerus by means of traction in a Thomas splint is a routine procedure in Harlem Hospital at the present time. Departure from this routine, except for fractures in the vicinity of the elbow joint, is rare. With this simple apparatus, overriding of fragments is corrected by traction increased by means of a Spanish windlass mechanism. Lateral and anteroposterior displacements of fragments or bowing may be corrected by means of a bandage attached to the iron bars of the splint and a pull or support applied in the necessary direction.



In a study<sup>1</sup> of 107 cases of fracture of the humerus, treated in Harlem Hospital from June 1, 1930 to June 1, 1932, several advantages of this type of treatment have been demonstrated. The application and maintenance of the Thomas splint is simpler and easier than that of balanced traction, and the cost of the apparatus is less. After application of the Thomas splint, the patient may be ambulatory immediately and will need very little nursing care. After discharge from the hospital, the patients who had been treated with the Thomas splint had earlier union and better immediate function than those treated with balanced traction. Although the length of stay in the hospital was approximately the same, those treated with balanced traction not infrequently required further splinting when removed from the apparatus, while the others never required any splinting.

We have, however, encountered one disadvantage in treatment with the Thomas splint. Great tension is sometimes required in order to reduce overriding fragments of bone and to maintain them in position. As a result of this marked tension, a feeling of great pressure or of pain

\* From the Surgical Service, Harlem Hospital, J. F. Connors, M.D., Director.

may be experienced in the axilla by some patients. Occasionally, in spite of padding, the skin may be irritated and may even slough.

In order to avoid these untoward symptoms, we have devised a plaster-of-Paris buttress to distribute diffusely the pressure of the ring against the axilla and the chest wall. The parts are well padded and plaster-of-Paris bandages are applied as indicated in the diagram. On the arm, the plaster reaches as far as the attachment of the deltoid muscle. Originally it was our intention to incorporate the ring of the Thomas splint in the plaster-of-Paris, but we have followed the suggestion of Ira Fink and apply the ring to the outside of the plaster buttress.

When the use of the Thomas splint produced pain, irritation of the skin, or sloughing, the patients were relieved of these symptoms by the application of the buttress. If it is properly applied, there is no more discomfort than might be expected from the use of the ordinary plaster-of-Paris jacket.

#### SUMMARY

The Thomas splint, with traction by means of a simple Spanish windlass mechanism, affords a simple, efficient, and economical method of treatment for fracture of the humerus. There is occasionally, however, the disadvantage of too great a localized pressure against the chest wall with accompanying pain and skin necrosis. This disadvantage may be overcome by the application of a plaster-of-Paris buttress (which is a modified jacket), allowing for the diffuse distribution of pressure of the ring of the Thomas splint and the resultant relief of pain.

1. To be published by J. F. Connors and M. S. O'Shea.

# A ZIPPER ATTACHMENT TO MUSLIN RETRACTOR FOR TREATING FRACTURES OF THE FEMUR IN CHILDREN

BY H. EARLE CONWELL, M.D., F.A.C.S., FAIRFIELD, ALABAMA

*Orthopaedic Clinic, Employees' Hospital*

In an article written by the author entitled "Acute Fractures of the Femur in Children" (*The Journal of Bone and Joint Surgery*, XI, 606, Fig. 10, July 1929), an original muslin countertraction apparatus was described. This retractor was applied across the patient's lower abdomen and pelvis, fitting snugly around the buttocks and upper end of the thighs, with the lower part of the retractor extending down below the patient's body for attachment to the bed. The changing and adjustments were made by lacing the lower part of the retractor up to the posterior surfaces of the thighs and buttocks.

The procedure of lacing has been improved by applying zippers, trademarked S-2-C (new) Separating Talon Fasteners, which completely separate. The zippers (Fig. 1) enable the lower part of the muslin retractor to divide all the way to the buttocks and thighs, thus making it possible for the retractor to be removed from the patient in the same way as with the lacing method. This has simplified the nursing of these cases,—the retractor has been made firmer and more stable, time is saved in applying the retractor, and the patient is thereby caused less annoyance.



FIG. 1

Retractor with zippers applied. Note that zippers separate completely, enabling lower part of muslin retractor to be removed entirely from around buttocks and upper part of thighs.

# FRACTURES OF THE TIBIA AND FIBULA

## A HANDY BAR USEFUL IN THE NON-OPERATIVE TREATMENT

BY VOIGT MOONEY, M.D., PITTSBURGH, PENNSYLVANIA

The bar which is shown below has been used by the author for several years in the non-operative treatment of fractures of the shafts of the tibia and fibula.

This bar is made of metal tubing and separated in the middle. It is

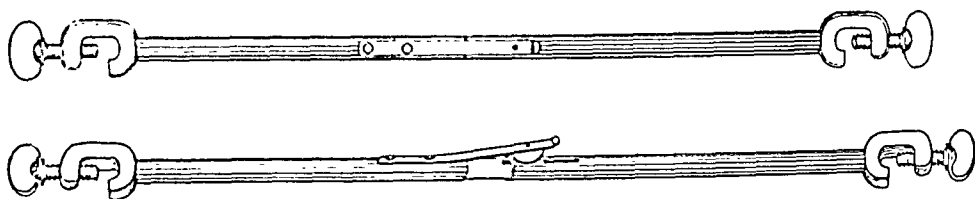


FIG. 1

The bar before and after separation. Note the lock.

of one standard size, and vertical stirrups of all operating and examining tables can be adjusted to meet it. Figures 2 and 3 illustrate its application.

In reducing a fracture of the leg, a plaster-of-Paris cast is applied in two sections (Fig. 3), the knee being flexed so as to relax the calf muscles. The bar fixes the flexed knee in position. Before section No. 1 is applied,

felt pads are put on the dorsum of the foot and over the tendo achillis.

While an assistant produces traction, the operator manipulates the overriding fragments and reduces the fracture. The two sections are then joined by means of a cuff of plaster. After the cast has been completed, trimmed, and split, the bar is released at the ends and divided by lifting the key; either half

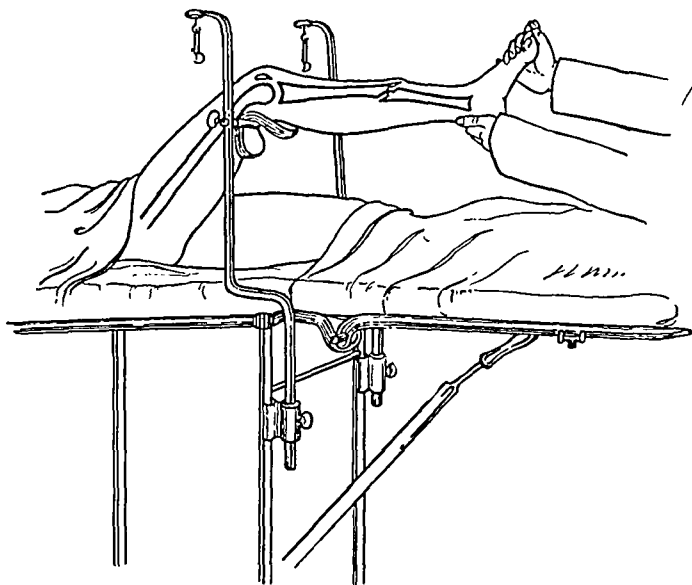


FIG. 2

The popliteal space rests on the bar which is attached to the standard stirrups of any operating or examining table.

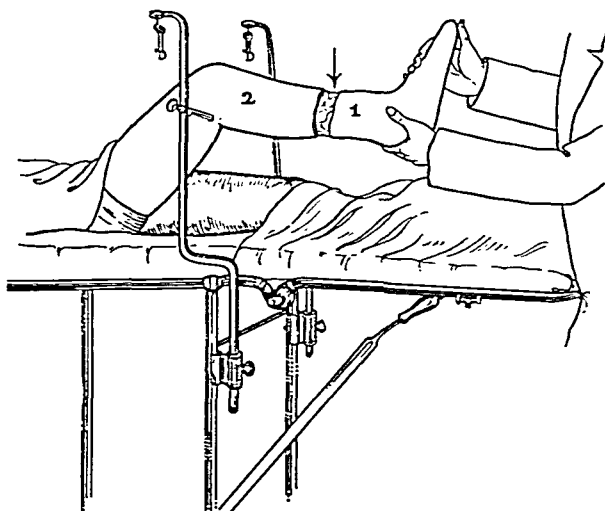


FIG. 3

Showing method of reduction of fracture of the leg.

of the bar is then pulled out of the cast.

The use of this bar has contributed to the ease with which the non-operative treatment of the fractures of the bones of the leg is carried out. Closed reductions are less difficult and fewer attendants are required in the operating room.

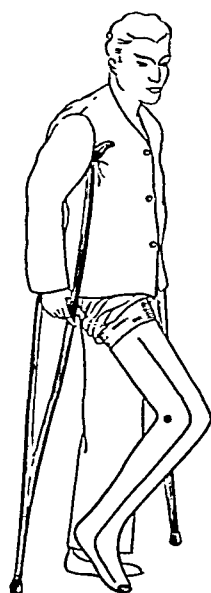


FIG. 4

Patient about on crutches. Note the hole in the cast through which the bar passed.



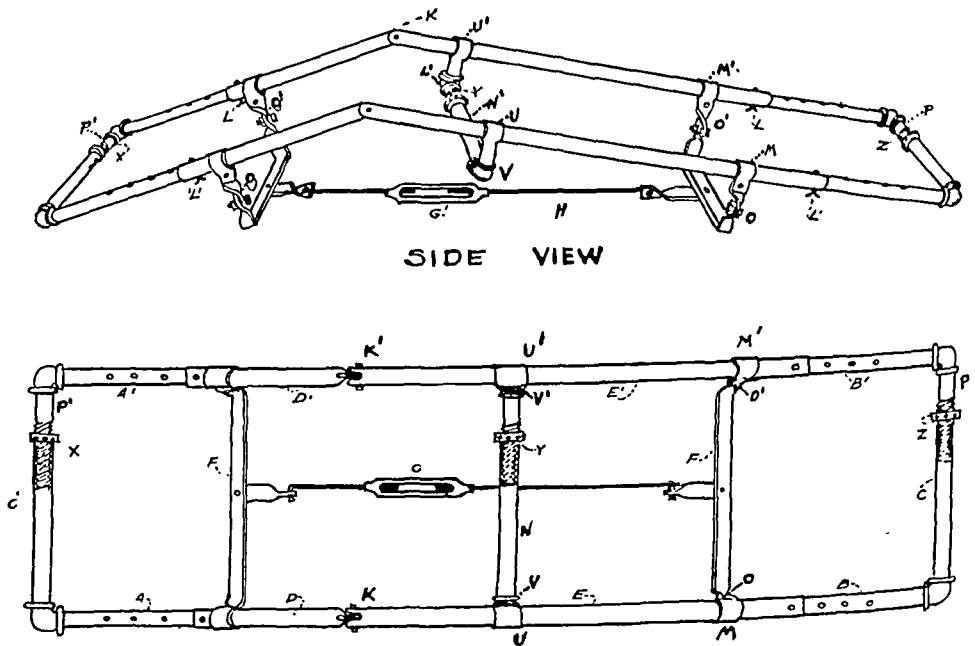
# A FURTHER MODIFICATION OF THE CONVEX ADJUSTABLE BRADFORD FRAME

BY B. S. LESTER, M.D., C. H. FORD, M.D., AND THOS. PURSER, JR., M.D.,  
BIRMINGHAM, ALABAMA

The convex adjustable Bradford frame, as originally described by Herzmark<sup>1</sup> and later modified by Conwell<sup>2</sup>, has been used extensively and with excellent results in the care of anterior compressed fractures of the spinal vertebrae, and satisfactory hyperextension of the spine has usually been obtained. In the authors' experience, the main source of irritation to the surgeon and to the other hospital attendants, as well as to the patient, has been the difficulty of keeping the canvas taut because of its tendency to sag under the constantly maintained weight of the patient.

Another change in the structure of the frame is here presented which satisfactorily eliminates this difficulty. It consists simply of the arrangement whereby the width of the pipe frame may be regulated at will, thereby altering at the same time the tension of the canvas.

Sketches in the figures show the following, quoted in part from Conwell's description: "A and A' and B and B' show solid iron rods 0.9375 inch by 14 inches long, which are held in place by the four 0.75-inch elbows, which are attached to C and C'" and to P and P' (Figs. 1 and 2). "The iron rods have through and through holes placed 2 inches apart, commencing 4 inches from the elbows. The iron rods fit within the 1-inch



TOP VIEW

FIG. 1

pipes shown as *D* and *D'* and *E* and *E'*, and allow for adjustments. The pipes and iron rods are held in place by bolts and wing nuts as shown in *L* and *L'* (side view). These winged bolts are 0.25 inch by 1.5 inch.

"*E* and *E'* are 40 inches long, and make a lock joint with *D* and *D'*" at *K* and *K'*. "This lock joint prevents the frame from overflexing. *E* and *E'* also receive the iron rods *B* and *B'*. *D* and *D'*, which make up part of the head of the frame, are 16.5 inches long, which connect with *E* and *E'* by the lock joint . . . and also allow for the reception of the solid iron bars *A* and *A'*."

*C* and *C'* are one-inch iron pipes, eighteen inches long, which are connected to *B* and *A* at the elbows and which receive at *Z* and *X* the threaded ends of pipes *P* and *P'*. Knurled and threaded bolts *Z* and *X*, screwed on the threads of *P* and *P'*, cause increase of the distance between *B* and *B'* and between *A* and *A'* when rotated counter-clockwise (Figs. 1 and 2).

Another supporting piece, *N* (Figs. 1 and 3), which has incorporated within it *Y*, a connection similar to *Z* and *X*, is attached to *E* between *K* and *M* and to *E'* between *K'* and *M'* by sliding sleeve joints *U* and *U'*. This may be moved along *E* and *E'* to any desired position before application of the canvas. By incorporation of the elbows *V* and *V'*, *N* is dropped below the level of the canvas covering, lends additional support, prevents sagging of the sides of the frame toward each other, and also renders aid in keeping the canvas stretched at the point of the patient's greatest weight.

The iron bands *F* and *F'* are attached by bolted connections *O* and *O'* (Fig. 1—side view) to *M* and *M'* and allow for increase in the width of the frame at these points. *G* is the turnbuckle which is arranged similarly to those described by Herzmark and by Conwell, and allows for the hyperextension.

The entire frame may be easily and conveniently suspended from the hospital bed by means of four supporting hooks (Fig. 4), made of flexible steel straps, one inch by twenty-five hundredths of an inch, and bent as shown in the sketch. Two of these hooks

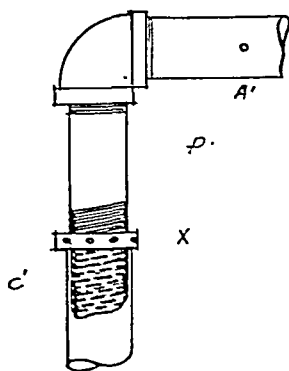


FIG. 2

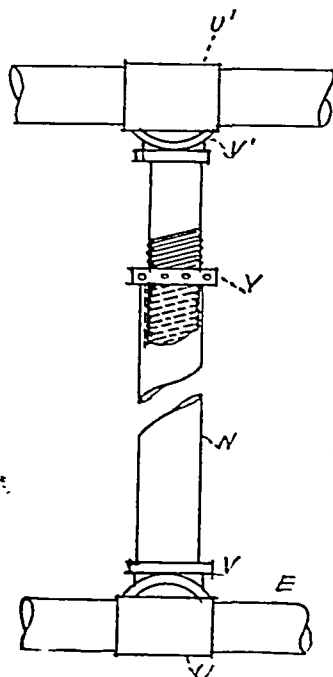


FIG. 3

hang from the head of the bed and two from the foot, those at the head being longer because of the extra height of that part of the bed.

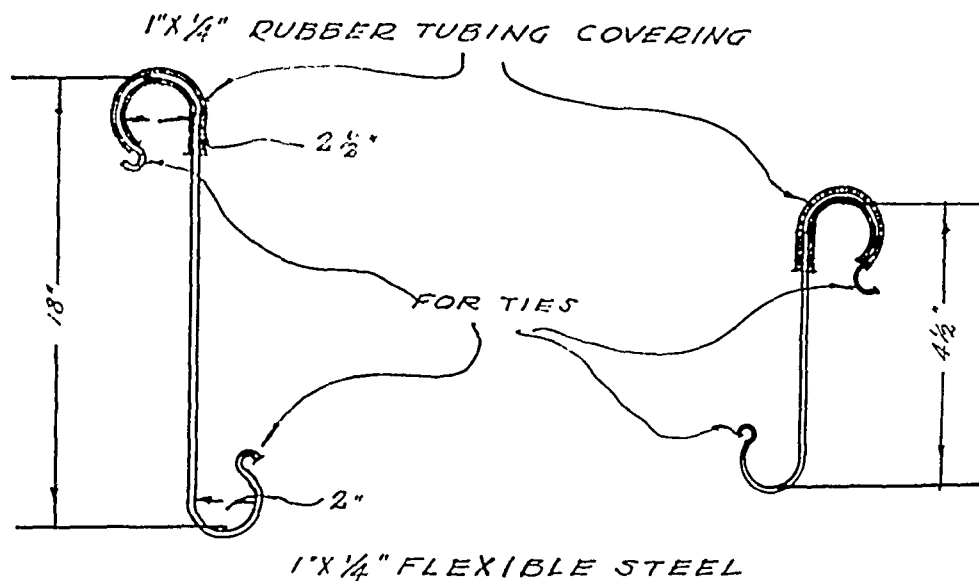


FIG. 4

The portion of the curve of each hook which fits over the bed is covered with one-inch by twenty-five hundredths of an inch rubber tubing to protect the enamel against scratching. Each end of each strap is bent so that light rope or cord ties may be used to give added security if desired, though this is usually not necessary.

The only advantage claimed for this frame is the feature of easy regulation of its width and of the tension of the canvas.

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## A FOOT EXAMINING STAND

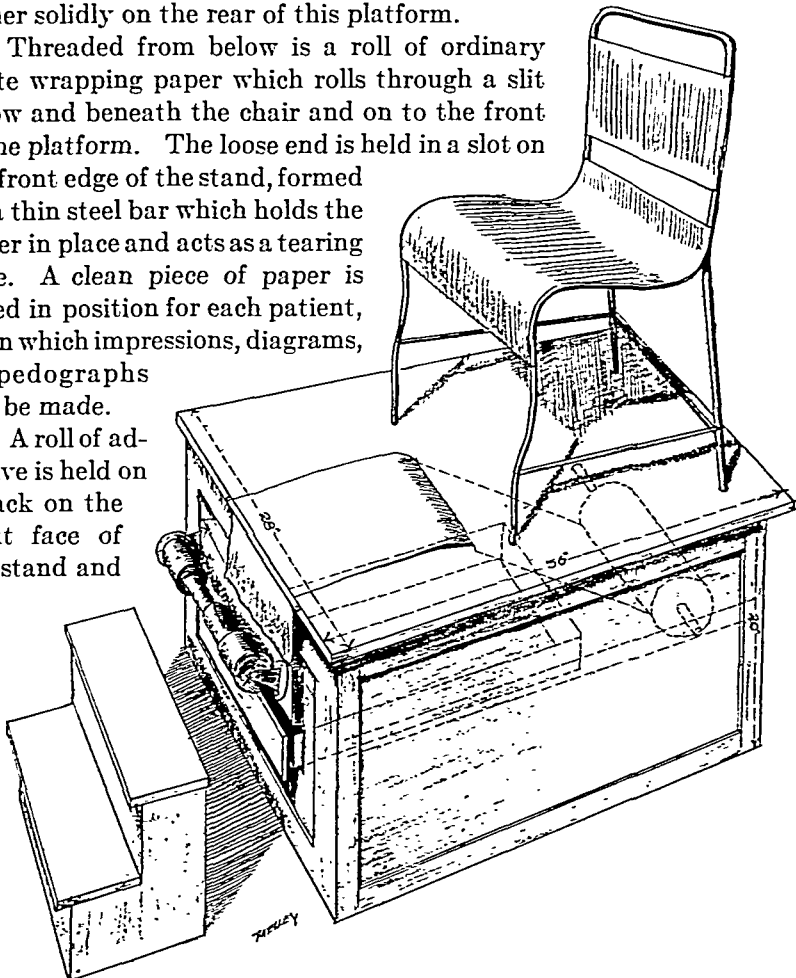
BY REX L. DIVELEY, M.D., KANSAS CITY, MISSOURI

It was found unsatisfactory to examine feet when the patient and examiner were on the same floor level; therefore, the following described stand was devised and has proved most satisfactory.

The examining stand or platform is some three feet square and twenty inches high, built of solid one-inch construction. A chair is mounted rather solidly on the rear of this platform.

Threaded from below is a roll of ordinary white wrapping paper which rolls through a slit below and beneath the chair and on to the front of the platform. The loose end is held in a slot on the front edge of the stand, formed by a thin steel bar which holds the paper in place and acts as a tearing edge. A clean piece of paper is rolled in position for each patient, upon which impressions, diagrams, or pedographs can be made.

A roll of adhesive is held on a rack on the front face of the stand and



a drawer just beneath this rack contains small instruments, measuring devices, etc. A combination step and seat allows the patient to mount the examining stand and also serves the examiner as a seat. This brings the level of the feet with that of the eye of the examiner when he is seated.

The rear or bottom of the platform is left open to allow replacement of a new roll of paper.

## A NEW KNEE BRACE

BY HARRY W. WOODWARD, M.D., COLORADO SPRINGS, COLORADO

The only excuse for the presentation to the profession of a new brace must be that it has distinct advantages over apparatus already in general use.

The usual types of knee braces have not proven entirely satisfactory as they do not have enough rigidity to prevent further injury, due especially to lateral blows or twists.

The brace illustrated below has the usual leather cuffs above and below the knee and the two hinged lateral bars. In addition, it has a third posterior, metal, hinged bar which increases its stability and effectiveness to a marked degree (Fig. 1). This posterior bar works through a hinged metal tunnel which allows the brace to flex easily and still lose none of its stability (Fig. 2).

The addition of this posterior bar gives an absolutely rigid brace laterally, and still does not interfere with flexion and extension of the knee (Figs. 3 and 4).

In addition to this posterior hinged bar, the only difference from the usual brace with hinged bars at the side is an extra leather cuff inside of the outer cuff. This internal cuff is attached behind and, when laced, tends to prevent the brace from sliding up. This cuff can be laced much tighter than the outer one.

Three years' use of this brace on the

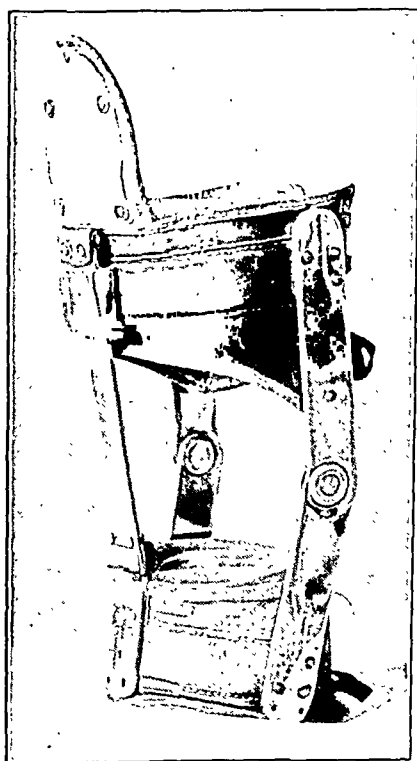


FIG. 1

Colorado College knee brace as for knee extended. Note strength of posterior bar.

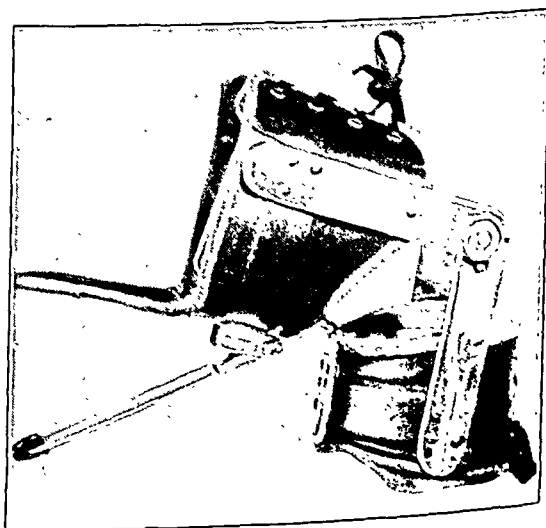


FIG. 2

Colorado College brace as for knee flexed.

football teams of Colorado College has demonstrated its effectiveness. At first glance it would appear that the posterior bar would be an impediment, but underneath either football trousers or ordinary street clothes it is not noticed and hugs the leg closely both in flexion and extension.

In addition to its usefulness on

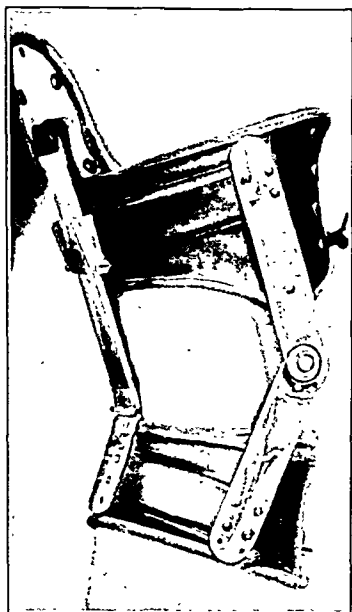


FIG. 3

Brace applied to knee in extension, as in standing position.

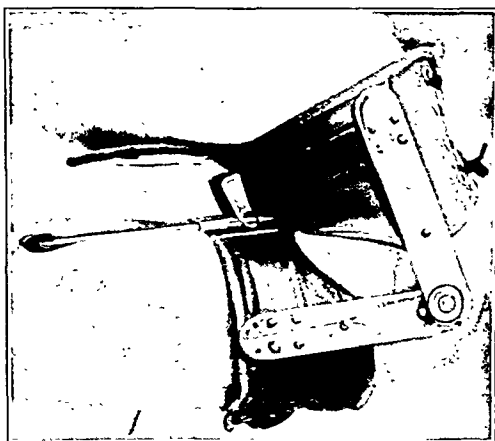


FIG. 4

Brace with knee flexed in position taken by a football player in the line.

athletic teams we have found it most useful in convalescent knee cases where flexion and extension are desired, but where it is advisable to prevent any lateral motion of the knee.

During the past year Dr. G. W. Hawley has seen a number of these braces in use and has expressed the opinion that it is the only satisfactory knee brace he has seen. He has urged the writer to present it to the profession.

The author acknowledges his thanks to Mr. George Thornton of Colorado Springs for his cooperation in working out this ingenious hinged posterior bar.

# SUBASTRAGALOID DISLOCATION WITH DISPLACEMENT OF ASTRAGALUS OUTWARD \*

BY SAMUEL W. BOORSTEIN, M.D., F.A.C.S., NEW YORK, N. Y.

Unusual dislocations are of considerable interest, especially if they have been reduced successfully by the closed method. Hence, the writer is reporting this case, trusting that it may prove of interest to others, and perhaps may tempt them to try the same procedure.

S. B., male, aged thirty-nine years, an electrician, while cleaning a window on September 29, 1932, slipped off the chair and sustained an injury to the left ankle. He immediately noticed a deformity of the ankle, but felt only slight pain. He was taken at once by ambulance to Fordham Hospital where a roentgenogram was taken. He was seen by the writer two hours after the accident.

Examination revealed a deformity of the left ankle, almost like a club-foot, of the talipes equinovarus variety. The foot was bent inward and inverted at the astragalocalcaneal joint. The internal malleolus was not palpable as it extended downward and outward; the external malleolus was displaced outward, almost piercing the skin. The entire foot was displaced downward and backward in an equinus position. The anterior aspect of the tibia was palpated freely at the anterior aspect of the ankle. The forepart of the foot at the calcaneoscaphoid joint was adducted as in a regular club-foot. The head and body of the astragalus were palpable at the outer aspect of the foot. There was no open wound.



FIG. 1

Before reduction.

\* Read before the Bronx Surgical Society on November 28, 1932.

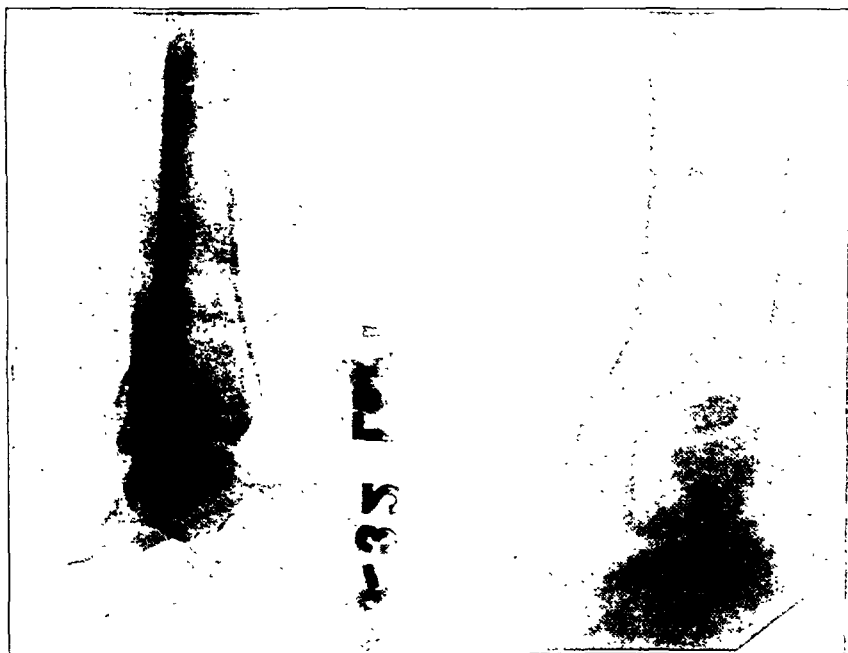


FIG. 2  
After reduction.

*Roentgenographic Examination:* The anteroposterior view (Fig. 1) shows a complete, external, lateral dislocation of the astragalus, due to a subastragaloid dislocation. The os calcis is dislocated posteriorly and upward, so that it comes in contact with the internal malleolus at the lower end of the tibia. The astragalus lies on the external aspect of the os calcis. The mortise joint of the ankle has not been displaced. There is no evidence of a fracture.

*Procedure:* The patient was anaesthetized, with the knee flexed at a right angle to take the pull off of the tendo achillis. The plantar flexion was then increased to an angle of about 130 degrees. The heel was held firmly by an assistant, while the author abducted the forepart of the foot with the left hand and pushed the head of the astragalus inward with the right hand. The abduction of the forepart of the foot, with the dislocation of the head of the astragalus, was then easily corrected. It was found impossible, however, to bring the foot forward and execute dorsal flexion, which was necessary for the replacement of the body of the astragalus.

It occurred to the writer that the anterior parts of the tibia and fibula were not held firmly by that manoeuver, and thus the foot could not be pulled forward. Therefore, a loop of muslin was placed over the anterior part of the leg near the ankle and traction applied with the operator's foot held downward in the other part of the loop (in the manner advocated by Jones for the reduction of a Pott's fracture). The flexion of the knee was kept up. The foot was then manipulated as follows: plantar flexion was increased to an angle of 140 to 150 degrees. The foot was then pulled forward along the line of direction in which the tibia and fibula had been displaced. With his foot on the loop, the writer was able to pull the leg downward, while the foot was pulled forward, during which an audible snap was heard and the astragalus slipped into place. The forepart of the foot was abducted slightly to get the forepart of the foot in better direction, and the foot was then flexed dorsally to an angle of 90 degrees. A plaster cast from the toes to the middle of the thigh was applied, the foot kept at a right



angle and everted, and the knee flexed at a right angle to relieve the tension of the tendo achillis.

A roentgenogram, taken October 3, 1932, showed complete reduction of the dislocation (Fig. 2). The patient had no pain the day following the reduction.

On October 4, 1932, a window was cut in the cast at the outer aspect of the foot, over the head of the astragalus, to guard against pressure and slough of the skin where the head was pressing before reduction. The plaster above the knee was removed in ten days. The plaster was changed in two weeks and at the end of three weeks the patient was permitted to walk on the foot. The patient made a perfect recovery.

I wish to thank Dr. Guggenbuhl, the house surgeon, for his kind assistance in this case.

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#### FREDERICK HENRY BAETJER

Dr. Frederick Henry Baetjer, Professor of Roentgenology at Johns Hopkins Hospital, died at his home in Baltimore on July 17. He was born on August 7, 1874. He received his degrees from Johns Hopkins University, he was an interne at this Hospital, and also followed for a year postgraduate courses in the University of Berlin. He devoted his entire life to the organization and development of the Department of Roentgenology at Johns Hopkins University, and was appointed Professor of Roentgenology in 1921. In his work Dr. Baetjer suffered injuries to his hands and eyes, but he labored on that the x-ray work might be put on a sound and scientific basis, and his contributions to that end were invaluable. Dr. Baetjer was a brilliant teacher; not only students but many doctors attended his daily clinics. He was a member of many medical and scientific societies, and was President of the American Roentgen Ray Society in 1911. He served as Major in the Medical Corps of the United States Army during the War. Dr. Baetjer was consultant roentgenologist to many of the leading hospitals in Baltimore and was the author of many valuable works on roentgenology, and his studies in regard to the value of x-ray findings in conjunction with the clinical findings in cases involving the bones and joints was an invaluable contribution to orthopaedic surgery.

# News Notes

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## END RESULTS OF THE TREATMENT OF JOINT TUBERCULOSIS

REPORT OF COMMITTEE APPOINTED BY THE AMERICAN ORTHOPAEDIC ASSOCIATION \*

Up to the present time this Committee is able to report on 235 cases from the clinics of Dr. F. C. Kidner, Dr. E. G. Brackett, and Dr. Emil Geist, and on 576 cases treated in the Lakeville State Sanatorium. These are cases from hospitals for adults and children, with the exception of Dr. Kidner's, in which all the patients are children. To obtain end results in these large hospitals for adults and children requires a long search, and it is extremely difficult, for patients discharged from these hospitals scatter to all parts of the world and do not follow instructions to report as to their condition. The only cases, therefore, in which we are sure of the end results are those of patients who we know have died. This is, therefore, a report of fatal cases.

Of 811 collected cases, the total number of deaths was 148, or eighteen and two-tenths per cent. Autopsies were obtained in twenty of the 148 cases. The presence of tuberculous micro-organisms was proved in eighty-six of the 148 cases.

At the Sanatorium at Lakeville, the percentage of deaths in reference to the region affected was as follows:

Spine.....	16.6 per cent.
Hip.....	17.0 per cent.
Knee.....	10.4 per cent.

*Age:* The age of the patient did not seem to have any relation to the death rate.

*Region:* The highest mortality occurred in disease of the low spine. In tuberculosis of the hip, males showed a larger mortality than females.

*The occurrence of pulmonary disease:* Fatal joint or osseous tuberculosis without active pulmonary disease is not uncommon. Of the fatal cases, thirty-seven per cent. showed active pulmonary disease; while sixty-three per cent. did not present pulmonary disease of any consequence.

*Renal complications:* Of the fatal cases, seven per cent. had tuberculous kidney disease.

### NON-OPERATIVE TREATMENT

The non-operative treatment in these cases consisted of fixation, extension, and heliotherapy. Fixation was obtained by plaster apparatus and plaster-of-Paris jackets, leggings, and spicas; and the method was practically the same in all hospitals. Extension was obtained by weights and pulleys, or in spinal cases by plaster shells or Bradford frame with firm pad. These orthopaedic measures were used in practically all the hospitals.

### OPERATIVE TREATMENT

Operation was attempted in only thirty of the 148 cases.

*Duration:* Of the twenty knee cases, fourteen died in less than one year; of forty-one hip cases, fifteen died in less than one year; of eighty-eight spine cases, forty-five died in less than one year. It should be stated that some of these patients did not enter the hospital until they were *in extremis*.

\* Presented at the Annual Meeting of the American Orthopaedic Association at Washington, D. C., May 9, 1933, by Z. B. Adams, M.D., Chairman.

*Frequency of meningitis and amyloid disease:* Of twenty knee cases, five per cent. died of meningitis and ten per cent. of amyloid disease; of forty-one hip cases, about twenty-seven per cent. died of meningitis and about twenty-seven per cent. of amyloid disease; of eighty-eight spine cases, fourteen per cent. died of meningitis and nineteen per cent. of amyloid disease.

EMIL GEIST, M.D., Minneapolis, Minnesota

F. C. KIDNER, M.D., Detroit, Michigan

R. I. HARRIS, M.B., Toronto, Canada

J. O. WALLACE, M.D., Pittsburgh, Pennsylvania

Z. B. ADAMS, M.D., *Chairman*, Boston, Massachusetts

**The Annual Roll Call of the American Red Cross** to enroll members for 1934 will be held from Armistice Day to Thanksgiving Day, November 11-30, 1933.

The pupils and friends of Professor Nové-Josserand, of Lyon, have formed a plan to present to him a medal of honor in commemoration of his thirty-five years of active hospital service. The medal is designed by Albert Herbemont and represents the Professor and a view of the old *Hôpital de la Charité* which has been the seat of his professional activities. Any donation to this fund by the friends and admirers of Professor Nové-Josserand will be received by Dr. André Rendu, 33 rue Sala, Lyon. The subscription of 100 francs will entitle the donor to a copy of the medal.

**The International Society of Orthopaedic Surgery** met July 19 to 22, 1933, at the Royal Society of Medicine in London, under the presidency of Prof. G. Nové-Josserand, of Lyon. The meeting was well attended, there being over 100 members present. The Committee appointed from the English members spared no pains to make the meeting a success and the plans were well arranged and carried out.

The symposium on the first day considered the mechanism of joint movements in general. Papers were read by Dr. H. von Bayer, Heidelberg; Dr. Francesco Delitala, Venice; and Dr. Richard Scherb, Zurich. The second scientific session considered the treatment of tuberculous arthritis of the hip joint. Papers were read by Dr. Philipp Erlacher, Graz; Dr. A. Maffei, Brussels; Dr. Étienne Sorrel, Strasbourg; and Dr. Melvin S. Henderson, Rochester, Minnesota. In the afternoons clinics were held at the London hospitals and these were well arranged and well attended. In the evening social events were held and the banquet, a brilliant affair, was held in the Dorchester Hotel, over 140 being present. The last scientific session on July 22 was devoted to a number of contributions by different members, more particularly on the technical questions and treatment. The afternoon was spent visiting the Lord Mayor Treloar Cripples' Hospital and College at Alton.

Dr. Murk Jansen of Leiden was made President-at-Large, Prof. V. Putti of Bologna, President, and Dr. Fred Albee of New York, Vice-President. The next meeting is to be held in Rome in 1936.

# Current Literature

**FRACTURES.** By Paul B. Magnuson, M.D. Philadelphia, J. B. Lippincott Company, 1933. \$5.00.

The author is writing mainly from his own practical, surgical experience—a valuable feature in any work on fractures—for the author passes on to his readers the methods by which he has met the problems which come to any surgeon who deals largely with this group of cases. He states that the object of the book is to give aid to the surgeon who first sees the fracture and to enable him to apply the necessary treatment at that most important time and, therefore, to avoid many of the unfortunate sequelae so often met with as well as much of the prolonged after-treatment.

The first four chapters are devoted to the discussion of general information on this subject and include the pathology and repair as well as the equipment necessary in the treatment,—including the forms and methods of application of splints and plaster.

In general, the operative procedures, except those necessary for the first treatment in some cases, are not given a prominent place—and with good judgment—for the main object of this book is to give information relative to the first treatment of fractures rather than to attempt a consideration of the entire subject.

The special fractures are then taken up regionally. A description of the types of fractures which occur in the different anatomical regions and of the anatomical conditions which influence the displacement of the fragments is followed by the technique of reduction and retention. The simplest methods of treatment sometimes advisable in the early periods are considered.

A chapter is devoted to the features of the postoperative treatment of various fractures, including instruction in regard to the proper therapy in treating fractures of the lower extremity which involve the joints. The author emphasizes the necessity of care of treatment in therapy and the need of direction on the part of the surgeon,—a supervision the value of which cannot be too strongly urged. In the portion treating of dislocation and fractures, the neurological features are considered at length, which is particularly helpful in the diagnosis and prognosis; and, since this book deals mainly with the first treatment of fractures, the value of attention to this part of the subject is having increased appreciation. The book is a particularly practical one.

**LE DISQUE INTERVERTÉBRAL. PHYSIOLOGIE, PATHOLOGIE ET INDICATIONS THÉRAPEUTIQUES.** By G. Mauric. Paris, Masson et Cie, 1933. 35 francs.

The work of Professor Schmorl has stimulated some of the best scientific minds to the further study of the intervertebral disc and the pathological changes which are associated with the injury of the various parts of its structure. These continued studies of this important subject are particularly valuable, for they link up the increasing knowledge of the pathological changes with the clinical data which the persistent investigations are disclosing, as well as the differentiation of those other conditions which show so great a similarity in both the roentgenographic and the clinical findings.

The author of the book has brought into his work both a clinical experience and a careful anatomical study, and has presented the results obtained by these two methods of investigation and has linked together the pathological and the clinical data. There is a careful presentation of the anatomy of the disc, and a review of the published work, but this historical review is more than a review, for it is the result of his own investigations, supplemented by the work already done by many authors. The pathology of the disc and the affections of the vertebral column, including the various forms of spondylitis and also the arthropathies, which are associated with change in this disc, are considered in relation to its structure and to the injuries or changes in development of the nucleus pulposus. The anatomy of the disc in different periods of life from the newly born to the

senile stage is given, and the conclusions from this study are presented as a brief summary,—a most convenient form to obtain a review of this portion of the subject. The author carries his discussion beyond the immediate affections of the disc and fractures and changes of the nucleus pulposus and the conditions resulting from this disturbance, and deals with the general affections of the spinal column, including the different forms of spondylitis and arthropathy and also the involvement of the nerves and the cord due to secondary changes. It is valuable to have a clear statement of the connection between the effects of the disturbances of the nucleus pulposus and the involvement of the spine and the distinction between them.

Little has heretofore been studied in regard to the subject of the nerve and cord pressure by the injury and the malformations of the disc which originate in the nucleus pulposus, but, from a study of a large number of case observations, the author has been able to discuss this portion of the subject from a practical point of view and its importance is clearly demonstrated.

ROSE AND CARELESS' MANUAL OF SURGERY. Edited by Cecil P. G. Wakeley, D.Sc., F.R.C.S., John B. Hunter, M.C., M.Chir., F.R.C.S., and William T. Coughlin, B.S., M.D., F.A.C.S. Ed. 14. Baltimore, William Wood and Co., 1933. \$9.00.

This new edition has been especially revised and rearranged to meet American needs.

Intended for students, it is to be praised for insistence on basic principles, for careful system and classification and for the presentation of a vast amount of information in a broad educational view of the subject. Also, the conservatism in point of view, the refusal to follow false enthusiasms, is fine. Nothing could be better than the paragraph on page 496, outlining what is *really* of value in the surgery of infantile paralysis cases.

One finds the same terse, common-sense point of view through the excellent chapters on abdominal and urological surgery.

Unfortunately the chapters touching on bone and joint work cannot be praised as freely, though the chapters on deformities and on joint disease suffer mainly from lack of space. Diseases of bone fare less well. Page 630 gives nothing like a plan of treatment or a perspective in myeloma (our giant-cell tumor) and, after all, Ewing's tumors are radiosensitive—for palliation at least.

Fractures need far more than the hundred pages here allowed and one condones omission, but there is, throughout this section, a vagueness as to what one does meet, what one does to it, and what is probably going to happen.

Fractures of the carpus give late trouble more than "occasionally" and the operative problem is worth more than a word. The account of compression fracture of the spine betrays no familiarity with this much discussed subject, and in relation to os-calcis fractures we are given vague advice which seems to apply to the rare avulsion type only, nothing as to treatment or outlook in the rather common and very serious compression fractures on which much good work has been done.

But, it is a good text book, full of substance—defective only, perhaps, as any book must be that attempts the impossibility of covering so broad a field.

THE PHYSIOLOGICAL EFFECTS OF RADIANT ENERGY. By Henry Laurens, Ph.D. (American Chemical Society Monograph Series.) New York, The Chemical Catalog Co., Inc., 1933. \$6.00.

Exaggeration of the "vital importance of sunlight" has prevailed during the past twelve years. Professor Laurens says: "Claims for its virtue have since been discredited, therefore placing patient and physician in a more true relationship with the merits of this form of treatment, . . . radiation is only one of the environmental factors that may affect vitality.

" . . . Nevertheless, radiant energy does play an interesting part in animal physiology, and is in some cases a remedial agent."

Four paragraphs deal with the use of radiant energy in the treatment of osteo-articular tuberculosis. The value of the text should not be based on this fact. The clinician learns from this high authority that, "the effect of radiation alone on bone tuberculosis is still a matter of conjecture. . . . Until more is known about selective radiation in the cure of tuberculosis of bone from the experimental standpoint, its specific action must continue to be a matter of speculation. While heliotherapy undoubtedly plays a large part in the results reported at Leysin (Rollier), it is only a part, not the whole, of the régime." Such conclusions are sound and favor careful consideration of other statements made by the author, although the reader may not fully agree.

For those interested in heliotherapy, or the therapeutic use of radiation from artificial sources as a substitute, a valuable service has been rendered by both the author and the American Chemical Society, in the publication of these fourteen chapters with nearly 800 references, covering a fifteen-year period.

**DAS WESEN DER SCHWEDISCHEN MASSAGE UND IHRE ANWENDUNG BESONDERS AUF DEM GEBIETE DER ORTHOPÄDIE.** Beilageheft zur *Zeitschrift für Orthopädische Chirurgie*, Bd. 59. By Dr. Konrad Port, Stuttgart, Ferdinand Enke, 1933. 60 marks.

In this work of 171 pages, the author emphasizes the usefulness of this form of treatment in numerous conditions of bones, joints, and muscles. Many of the long-standing, painful ailments, commonly found in joints and especially in muscles, can be cured or definitely improved. Emphasis is laid on the necessity of thorough training in the work, even for the physician, in order to obtain the skill needed in detecting pathological conditions as well as removing them.

The author calls attention to the distinction between the method of superficial massage which is ordinarily employed and the method used by the Swedish school.

The disease conditions for which this remedy can be successfully applied are grouped under the headings of chronic rheumatism, myalgias, static deformities, and traumata. Excellent descriptions are given of the subjective symptoms and the objective findings. Illustrations and x-ray reports are omitted, although numerous case reports are included in the discussions.

It is safe to say that a more general application of the principles advocated by the author would be a distinct help in relieving many cases of prolonged disability. It is, therefore, reasonable to expect that, in the first place, industrial surgeons would avail themselves of a method of treatment which has stood the test of a long period of time.

**THE CONTROL OF FOOTBALL INJURIES.** By Marvin A. Stevens, M.D., and Winthrop M. Phelps, M.D. New York, A. S. Barnes and Co., Inc., 1933. \$3.00.

The book undoubtedly fills a long felt want, in giving something concrete for the coach or trainer and doctor connected with football teams to turn to for reference.

The book—supposedly being written for coaches, trainers and medical advisers—discusses many and sundry types of injuries sustained in athletics, but fails to discuss the differential diagnoses and is lacking in details of specific treatment. It does not emphasize the possibility of seemingly trivial injuries becoming serious, which surely is one of the most striking observations to be made by medical men connected with athletic squads.

The portions of the book devoted to diagnosis and treatment are not sufficiently detailed for a medical reference book, yet contain enough information which when placed in the hands of non-medically trained coaches or trainers—who unfortunately are in charge of the care of injuries in the majority of schools or colleges in America—may make them more dangerous than ever.

There is much valuable information for the coach regarding methods of instruction—the handling of the body and ways by which the player can protect himself from injury. Stressing adequate medical examinations of prospective football candidates, and insisting on medical supervision of athletic squads are points extremely well taken.

The book is profusely illustrated—for the most part cuts from movies of actual games.

While these are interesting from a football man's point of view, they are too small to be of value in illustrating mechanisms by which injuries are produced.

Since the authors have particularly in mind the coach and the trainer, the emphasis is naturally laid on the information intended for them.

**MASSAGE AND REMEDIAL EXERCISES IN MEDICAL AND SURGICAL CONDITIONS.** By Noël M. Tidy (Princess Mary's Royal Air Force Hospital, Halton, England). Baltimore, William Wood and Co., 1933. \$5.25.

This handbook, prepared, as the author states, for "senior and junior students of physiotherapy", fulfills its purpose. It is a well balanced résumé of many surgical and medical conditions in which massage and therapeutic gymnastics should play a rôle too often insufficiently assigned to them.

For the most part, the plan for each subject includes definition, classification, symptoms, pathology, and treatment. The physician and surgeon will find a repetition of much that he knows in the preliminary treatment of each subject; the physiotherapist will be able to get the setting of each subject clearly and succinctly. It is in the paragraphs on treatment that the book is most valuable to the physiotherapist, as well as to the physician or surgeon who wishes to know more about massage and corrective gymnastics. To each subject is given a brief outline of recognized treatment, a statement of the place of massage and remedial exercises in the entire treatment, and usually a statement of the types of massage to be used and a list of beneficial exercises. At times the nomenclature of these exercises differs from that in general use in America, but the simplicity of the descriptive words used is such that one familiar with corrective exercises may readily understand them. The illustrations, of which there are perhaps not enough, aid in interpretation of the exercises. The exercises outlined are largely in conformity with those most used in America.

It is refreshing to read a book, written by a specialist in physiotherapy, which does not lay undue emphasis upon the one phase of treatment which she knows. One gets the impression that the author does know her subject well, but that she also has been much in touch with physicians and surgeons in her work and realizes that there must be more than "one string to her bow", when treating disease and deformity. This book is a valuable addition to therapeutics.

**THE AMERICAN ILLUSTRATED MEDICAL DICTIONARY.** By W. A. Newman Dorland, A.M., M.D., F.A.C.S. Ed. 16. Philadelphia, W. B. Saunders Co., 1932. \$7.00; with Thumb Index \$7.50.

The medical public will welcome the sixteenth revised edition of the American Illustrated Dictionary which has recently appeared. This work has won its place in the medical world and the new, rapidly changing and increasing terms which are an accompaniment of the advances in medicine and surgery make such a work still more necessary. To meet this need 3000 new words and terms have been added, many times with ample description of new methods or processes which they designate. The definitions are also frequently illustrated and many drawings and photographs have been added to those already in the previous editions.

This work is a complete dictionary of terms used in medicine, surgery, dentistry, pharmacy, biological chemistry, nursing, veterinary science, biology, and medical bibliography. It is a book of 1493 pages and 941 illustrations. But it is more than a dictionary, for it gives brief and valuable information on very many of the subjects which the words represent.

There are also special tables of staining methods and tests, etc., which give the necessary directions for their use, and many of the topics and subjects are very thoroughly illustrated, many times with colored photographs. This portion of itself makes the work a handy book of reference to the practical medical man.

An interesting feature also is the portraiture and brief mention of prominent men who

have contributed to the science of medicine and who have given their names in the development of the terminology of medicine. As a descriptive feature are line drawings and photographs portraying anatomical and pathological structures of the body,—for instance, the formation of joints with the distribution of the ligaments, etc., also special systems of circulation.

The work could be called a dictionary and a reference book, and this new edition will find its place with all active medical men and in libraries.

**THE JOY OF LIVING. AN AUTOBIOGRAPHY BY DR. FRANKLIN H. MARTIN.** Garden City, Long Island, Doubleday, Doran and Co., 1933. 2 Vol. \$7.00.

The title of this book is a happy introduction to a detailed account of the experiences of one who encountered and passed successfully through the physical hardships of early life. It suggests, and perhaps illustrates, the important part which those early struggles, combined with a native capacity, often play in determining that success which comes later in the real periods of a man's career.

It is as an organizer and as an administrator that Dr. Martin is best known, and will always be regarded. He has the vision to see things in their larger relations and their possibilities of development in perspective, and such vision has served him in the establishment of the several successful projects in which his initiative has been so evident. He has had the judgment to recognize the time when some of these larger movements in the medical world were ready to be put into action.

The second volume is confined to the consideration and discussion of some of the medical activities during the war. From his position as a member of the Advisory Commission to the Council of National Defense, and as Chairman of the General Medical Board, he was intimately conversant with many of the more important movements which mobilized so large a number of medical men into an active service.

This Advisory Commission was in close contact with other mobilized bodies of citizens and could give the benefit of its counsel and play an important part in unifying the various efforts in that critical and difficult time. In these positions, Dr. Martin employed his unusual powers of organization toward accomplishing such unification of these agencies. The medical profession will take particular interest in this historical review of this tense and critical period in which it supplied a sudden need and played an active part. The book is full of interesting episodes, many of them personal, covering the time from boyhood, through early professional and later administrative periods of the author's life.

**A SYNOPSIS OF SURGERY.** By Ernest W. Hey Groves, M.S., M.D., B.Sc. F.R.C.S. Ed. 10. New York, William Wood and Co., 1933. \$5.00.

American surgical literature is singularly lacking in texts of this character. The plethora of reference books on surgery, patterned mostly after one standard model, has resulted in the crowding of book shelves with many volumes, the size and number of which have a tendency to increase steadily, to which reference is only rarely made by the busy practitioner, and which are too detailed and exhaustive for the average student. English surgeons and teachers have shown an appreciation of the desirability of a small, well indexed, and succinct epitome of accepted surgical practice and the publishers of this little volume of Mr. Groves's have rendered a great service to American surgeons and students in bringing out this revised tenth edition. It will be found to be an extremely comprehensive and sound guide to modern surgical diagnosis and practice and, though it may not supplant entirely the need for a more exhaustive treatise, will certainly be referred to far more frequently than the more pretentious treatises on surgery.

**HISTORY AND SOURCE BOOK OF ORTHOPAEDIC SURGERY.** By Edgar M. Bick, M.A., M.D. New York, The Hospital for Joint Diseases, 1933. \$1.50.

The author states that the object of this book is to give a history of Orthopaedic Surgery from ancient times to the present day, and he has presented a review of the



growth of Orthopaedic Surgery, beginning with the practices of those earliest times, as shown by the remains of primitive man. It is interesting to find how much can be learned of the methods by the fragmentary evidence of those periods. He has first traced the development through the various epochs by means of the different methods and appliances in use in those times, and, through their application, has shown the influence of the principles employed. The pathological and traumatic affections of bones and joints evidently excited a great deal of interest in those earlier periods, and many of the mechanical principles then in vogue are now applied in a modified way. One can also form an opinion through this information of the type of men who have occupied themselves with this special work. In the more modern times he traces the development through the evolution of surgical procedures resulting from the increased knowledge of the fundamentals of medicine and surgery, and he leads to the present status of this specialty and its influence on the development of institutions which are essential parts of the methods and procedures of the present day. This book will be found to be full of historical interest. The very large amount of material is well arranged and the story is told in a way to interest the reader.

*The Journal* wishes to acknowledge the receipt of the following publications sent to the Editorial Department:

- Bulletin of the National Tuberculosis Association, XIX, Nos. 8, 9, 1933.
- Bullettino e Atti della Reale Accademia Medica di Roma, LIX, Fasc. 1-5, 1933.
- Cirugía Ortopédica y Traumatología, I, Num. 1-3. Havana, 1933.
- Fondation de la Clinique-Manufacture Internationale du Dr. A. Rollier, à Leysin. Rapport de 1932.
- The Journal of the Indian Medical Association, II, Nos. 5-10. Calcutta, 1933.
- Journal de Médecine de Bordeaux et du Sud-Ouest, CX, No. 16, 1933.
- Knochenbrüche und Unfallchirurgie in ihren Beziehungen zur Umwelt. Lorenz Böhler. Vienna, Wilhelm Maudrich, 1933.
- Entstehung, Erkennung und Behandlung der Fersenbeinbrüche. Lorenz Böhler. Vienna, Wilhelm Maudrich, 1933.
- Medico-Surgical Suggestions, II, Nos. 5-7. Madras, 1933.
- Hospital for Joint Diseases of the City of New York, Twenty-Sixth Annual Report, 1932.
- Norsk Magasin for Laegevidenskapen, XCIV, Nr. 7, 9. Oslo, Norway, 1933.
- Slovanský Sborník Ortopedický, VIII, Sešit 3, 4. Brno, Czechoslovakia, 1933.
- Boletines y Trabajos de la Sociedad de Cirugía de Buenos Aires, XVII, Nos. 1-19, 1933.
- La Tribuna Médica, VII, Nos. 196-203. Havana, 1933.
- Verzeichnis der Ärztekurse im Studienjahre 1933-1934. Das Kursbüro der Wiener Medizinischen Fakultät. Vienna, 1933.
- Experimentelle und Klinische Studien über Avertinnarkose. Nils Gyllensvärd. (Acta Chirurgica Scandinavica, LXX, Supplementum XXII.) Helsingfors, Finland, Mercators Tryckeri Aktiebolag, 1933.
- Studien über die Gaswechselerhältnisse im Darm bei Sogenanntem Paralytischem Ileus. Eine Klinisch-Experimentelle Untersuchung. Herman Wahren. (Acta Chirurgica Scandinavica, LXX, Supplementum XXIII.) Stockholm, Kungl. Boktryckeriet, P. A. Norstedt & Söner, 1933.
- Zur Behandlung der Appendicitis-Peritonitis. Mit Besonderer Berücksichtigung der Frage nach Primärsutur und der Behandlung von Postoperativem Ileus. Eine Klinische Studie. Gunnar Bauer. (Acta Chirurgica Scandinavica, LXX, Supplementum XXIV.) Lund, Sweden, Berlingska Boktryckeriet, 1933.
- Beiträge zur Kenntnis der Postoperativen Blutveränderungen. Peter Windfeld. (Acta Chirurgica Scandinavica, LXX, Supplementum XXV.) Copenhagen, Levin & Munksgaard, 1933.

HALLUX RIGIDUS UND SEINE BEHANDLUNG (Hallux Rigidus and Its Treatment). J. P. Strömbeck. *Acta Chir. Scandinavica*, LXXIII, 53, 1933.

A review of the literature and the detailed reports of twenty-three personal cases cover the subject of hallux rigidus in monographic style. Contracture of the short flexor of the great toe and the soft parts of the plantar surface is the usual cause of limited dorsiflexion. Arthritis of the basal joint is a common etiological factor. Excessive weight-bearing on the congenitally long narrow foot with a long first toe and metatarsal predisposes to deformity of the first metatarsal head. X-ray tracings of the first metatarsals in the writer's cases are shown in aggregate.

Operative treatment is usually successful, but arthrodesis of the basal joint is to be avoided. Occasionally removal of the dorsal exostosis is sufficient. In the mild case the short flexor may be tenotomized, but in the severe one the proximal end of the proximal phalanx must be resected.—W. P. Blount, M.D., Milwaukee, Wisconsin.

A CLINICAL STUDY OF THE CAUSATION OF PSEUDARTHROSIS OF THE DIAPHYSES OF THE LONG BONES OF THE EXTREMITIES. Arvid Hellstadius. *Acta Chir. Scandinavica*, LXXIII, 111, 1933.

On the basis of a study of eighty-one non-unions of the shafts of long bones, the writer arrives at numerous conclusions, some of which are as follows:

In cases of pseudarthrosis in which multiple fractures had been present, the union of several fractures is simultaneously inhibited.

A relative deficiency of vitamin C has not been proved an influence in producing pseudarthrosis.

The tendency to non-union is slight in childhood.

The arterial blood supply to the diaphysis may possibly play some part in the production of pseudarthrosis.

Seven per cent. of compound fractures resulted in non-union. Simple fractures treated by operation yielded 2.4 per cent. and those by closed methods 0.23 per cent. pseudarthroses. Operations performed in the first three days gave a higher percentage of non-unions than those done at a later stage.—W. P. Blount, M.D., Milwaukee, Wisconsin.

ZUR BEHANDLUNG VON LORDOKYPHOSEZUSTÄNDEN BEI KINDERN UND JUGENDLICHEN (The Treatment of Lordosis-Kyphosis Deformities in Children and Adolescents). Mauritz Persson. *Acta Orthop. Scandinavica*, IV, 182, 1933.

The principle of the Haglund scoliosis jacket has been successfully utilized in the correction of several cases of kypholordosis. With the patient bending forward so that the back is horizontal and "buckled like a cat's", a plaster cast is applied to the torso. A window is cut over the lumbosacral region instead of over the abdomen. As the patient straightens up, there is passive correction of the double curve, which is in part active of the kyphosis.—W. P. Blount, M.D., Milwaukee, Wisconsin.

IRRADIATION IN THE TREATMENT OF BONE TUMORS. George E. Pfahler. *Am. J. Cancer*, XVIII, 318, 1933.

The author presents a general paper on radiation therapy in bone tumors, and a review of his previously published results in the treatment of osteogenic sarcoma. He reports 25 per cent. (nine out of thirty-six) of his series as well and symptom-free at the end of five years or more. All but one of these cases had the benefit of operation as well. He concludes that "preliminary irradiation of the tumor area and irradiation of the pulmonary area followed by amputation has given us the best results to date".

The author states that in giant-cell tumors radiation is the treatment of choice. In no case has he failed to obtain definite improvement. With young patients there is definite evidence of repair within a month after treatment is started. He has never seen damage to normal bone growth caused by radiation of these tumors. There is no need

of carrying the treatment to the extent of causing skin changes. In his experience recalcification is delayed if there has been an operation on the tumor before radiation therapy is begun.

Radiation is of great palliative benefit in cases of Ewing's tumor, Hodgkin's disease of bone, and multiple myeloma. Among metastatic bone tumors, cancer of the breast and thyroid yield better than others to radiation therapy. Pathological fractures due to metastatic cancer frequently unite under radiation.

The paper is well illustrated with roentgenograms and case histories, and gives some details of the technique of the therapy employed.—*Grantley W. Taylor, M.D., Boston, Massachusetts.*

**MALIGNANT GROWTHS FOLLOWING RADIATION.** Editorial. *Am. J. Cancer*, XVIII, 622, July 1933.

After review of the well known examples of the development of malignancy in areas subjected to radiation, either experimentally or clinically, the editor concludes that irradiation alone, unless serious tissue lesions are produced, is not sufficient for the induction of malignant changes. The presence of inflammatory changes in the tissues renders them more susceptible to malignant degeneration under the influence of radiation. It is stated that there are now recorded eighteen examples of sarcoma following irradiation of joint tuberculosis in human beings. Obviously the raying of tuberculous joint lesions should be avoided if healing can be produced by any other type of therapy.—

*Grantley W. Taylor, M.D., Boston, Massachusetts.*

**TUMORS OF THE PARATHYROID GLAND.** Report of Two Cases. F. W. Rankin and J. T. Priestley. *Am. J. Surg.*, XX, 298, 1933.

The authors report two cases of tumor of the parathyroid gland with generalized osteitis fibrosa cystica. Removal of the tumor in one case resulted in cure of the symptoms of weakness and pain in bones and joints.

In the other case death followed seventy-eight days after operation. The patient, a woman aged forty-seven years, developed anorexia, vomiting, tetany unrelieved by intravenous parathormone and calcium, nutritional oedema and, finally, extreme weakness and prostration with death. At autopsy there were found three small, normal parathyroid glands which were apparently insufficient to carry on the necessary function. In this case there was extreme instability of the blood calcium and phosphorus following operation.

It is suggested that information at hand now does not justify parathyroid surgery except in the case of generalized osteitis fibrosa cystica, and even in such a case one must take care to leave undisturbed enough parathyroid tissue to carry on the function normally.

A short discussion of a few of the points in operative technique is given.—*Allan Lloyd, M.D., Iowa City, Iowa.*

**MADURA FOOT.** A Third Case of Monosporosis in a Native American. Moses Gellman and J. A. Gammel. *Arch. Surg.*, XXVI, 295, 1933.

This condition was termed so by the natives of India to designate a deformity of the foot most commonly seen in the vicinity of Madura. It is a mycetoma, a growth or granuloma characterized by sinus formation. White, yellow, black, or red granules made up of fungous elements are found in the discharge or embedded in the pathological tissue, which differentiates it from other mycoses. The maduromyces have grains composed of large segmented mycelian filaments possessing well defined walls and usually chlamydospores (actinomycoses are non-segmented).

A third case of monosporosis occurring in a native adult negro American is reported. These mycetomata rarely respond to medical treatment but require surgical amputation, as did this case. A mycosis should always be considered in all cases of chronic osteo-

myelitis, tuberculosis, or syphilis. This fungus injected into the knee joints of rabbits resulted in a purulent arthritis with periartritic abscesses from which cultures were positive, this being the first instance in which experiments of this nature on animals, carried out in the United States, yielded positive results.

Clinically, this patient demonstrated a marked destruction of all the bones of the foot. Biopsy indicated syphilis or tuberculosis. The leg came to amputation. Pathological examination demonstrated the granules.—*J. Kulowski, M.D., Iowa City, Iowa.*

**RESECTED KNEE JOINTS.** R. K. Ghormley and E. A. Brav. *Arch. Surg.*, XXVI, 465, 1933.

A study has been made of the clinical history, roentgenograms, lesions discovered grossly and microscopically, and results of inoculation of guinea-pigs in a series of 236 resections and nine amputations of the knee joint. One hundred and twenty of these joints were totally intact for complete study. An analysis is given in detail, covering the main features,—such as gross and microscopic pathology, etc.

Of particular interest is the following summary:

The preoperative diagnosis was incorrect in 24.4 per cent. of the cases of tuberculosis and in 13.7 per cent. of the non-tuberculous arthritic cases. The gross specimens and x-rays varied so considerably that it was often impossible to arrive at an accurate diagnosis. The inoculation of guinea-pigs proved incorrect in 12.5 per cent. of the twenty-four cases in which this was done. The diagnosis made by biopsy and other operative tissue was accurate in all but 3.2 per cent. of the cases, an error of omission.

In 168 of these cases tuberculosis was found by microscopic examination or guinea-pig inoculation. Sixty-six cases were end results of septic joints, old traumatic joints, and old osteomyelitis. Nine were cases of atrophy and two of Charcot's disease.

In comparing the specimens and history it was found that, as a general rule, the progress of the non-tuberculous types of infection was much more rapid than of the tuberculous. In 56 per cent. it appeared grossly that the condition was advanced in all the tissues, in 37.2 per cent. it appeared to be primarily in the synovial membrane, and only 6.8 per cent. evidenced primary osseous lesions. By the time a diagnosis is clinically possible, the lesion is wide-spread and the initial localization is of little practical significance. In 34.4 per cent. the site of the lesion was in the tibia, in 10 per cent. in the femur, and in 3 per cent. in the patella; the rest could not be determined (52.6 per cent.).

In the tuberculous cases the destruction of cartilage was due to the pannus formation, subchondral granulation, and attrition; whereas in the non-tuberculous, the cartilage was denuded by attrition and digestion. In 29.4 per cent. of the tuberculous forms, the cartilaginous destruction was greatest at the margins of the joint, while in 20.6 per cent. it was definitely greater at areas of pressure. In twenty-nine cases sequestra of varying sizes were noted in the tuberculous group.

In all cases in which changes are apparent in the roentgenograms, the disease is probably well advanced, particularly in tuberculosis. In 45.5 per cent. of the non-tuberculous group there was more cartilaginous destruction than was evident in the x-rays. On the other hand, actual osseous changes were exaggerated on the x-ray film, but in only seven cases were sequestra demonstrated. All in all, the x-ray may be inconclusive and even misleading.

The actual histological examination of sufficient tissues leads to the least error in diagnosis. A negative tuberculin reaction is of more significance as being against a diagnosis of tuberculosis.—*J. Kulowski, M.D., Iowa City, Iowa.*

**BEITRAG ZUR BEHANDLUNG DER SCHENKELHALSFRAKTUR: FEMORO-PELVINE VERSCHRAUBUNG NACH HOTZ** (Contribution to Question of Treatment of Fracture of Femoral Neck: Femoro-Pelvic Screw Fixation of Hotz). H. Hillebrand. *Beitr. z. Klin. Chir.*, CLVII, 266, 1933.

The Whitman abduction method of treatment of fracture of the neck of the femur is,

in general, the procedure of choice. However, in certain cases where conditions are unfavorable for this form of treatment, osteosynthesis according to the method of Hotz produces very satisfactory results. This consists of securing the fragments by means of a metal screw through the trochanter, neck, head of the femur, and the acetabulum. A modification of this method is now used by the author, in which the acetabulum is not included.

This procedure has been used in nine cases. In seven, good functional results have been obtained, and in the other two the results were satisfactory. The period of convalescence has been very materially shortened.

Reports of nine cases are briefly given in the article. There is also a complete description of the technique of the operation, as well as the indications for this operation.—

*R. J. Dittrich, M.D., Fort Scott, Kansas.*

**ACUTE INFECTIVE OSTEOMYELITIS.** A Review of 262 Cases. L. N. Pyrah and A. B. Pain. *British J. Surg.*, XX, 590, 1933.

This is a study of a ten-year period of the cases in the General Infirmary at Leeds. Seventy-one of the 262 cases were fatal (27 per cent.). Of fifty-one cases submitted to autopsy, all but six showed pyaemic lesions. The causative organism was most commonly *staphylococcus aureus*.

All cases were operated on. In forty-six instances, incision and drainage of the subperiosteal abscess was all that was done at the primary operation and there were eleven deaths. Sixteen others had the same operation but required secondary operations.

The gutter operation was done primarily 176 times with fifty-two deaths. Primary partial diaphysectomy was the operation in twenty instances with but one death. Two cases were treated by the Orr method and both patients died.

The writer concludes that a moderately conservative treatment is the best policy.—

*Ernest M. Daland, M.D., Boston, Massachusetts.*

**SERUM THERAPY IN POLIOMYELITIS.** Jean Macnamara. *British Med. J.*, I, 526, Mar. 1933.

Stimulated by Simon Flexner's recent article, Dr. Macnamara reviews the records of clinical experience with immune human serum in the treatment of poliomyelitis. She rightly points out the many difficulties in applying this form of serological treatment, (variations in potency of available serum, lack of standardization of the product, difficulties in reaching any uniform, standardized unit, difficulties in obtaining human serum, and its cost). After reviewing all the published evidence, she concludes that the facts do not by any means indicate that the serum is of no value. She concludes on a note of hope that further and more carefully controlled use of the serum will prove it to be of value.—*R. I. Harris, M.B., Toronto, Canada.*

**MUSCLE EXTRACT TREATMENT OF INTERMITTENT CLAUDICATION.** Maurice Newman. *British Med. J.*, I, 611, Apr. 1933.

Newman discusses the evidence supporting the idea that various types of tissue extract and particularly muscle extract have vasodilating powers. He has applied this principle to the treatment of eleven cases of intermittent claudication. Of these, nine cases received great benefit and relief of symptoms. The treatment he describes appears to be similar in principle to that with acetylcholine,—*viz.*, the administration of a drug having definite power of vasodilatation of peripheral arterioles.—*R. I. Harris, M.B., Toronto, Canada.*

**TRANSITORY ARTHRITIS OF THE HIP-JOINT IN CHILDHOOD.** An Investigation of Arthritis of the Hip in Ninety-Seven Children. R. W. Butler. *British Med. J.*, I, 951, 1933.

Butler relates the histories of a group of children sent to the tuberculosis hospital at

Pyrford with low-grade arthritis of the hip in whom it was not possible to make a definite diagnosis of tuberculosis of the hip on admission. These were called "observation hips". Careful follow-up revealed that three proved later to be tuberculous. Of the twenty-two non-tuberculous cases, two were hysterical hips and one was probably a syphilitic lesion, since it cleared up together with other definite syphilitic lesions under appropriate treatment. The remaining nineteen cleared up spontaneously after varying periods of time. Fever was present in six. Trauma did not play any part. After discussing the possible etiological factors, Butler concludes that low-grade infection is the most probable cause.—

*R. I. Harris, M.B., Toronto, Canada.*

**A CASE OF OSTEITIS DEFORMANS TREATED WITH PARATHORMONE.** G. H. Colt and A. Lyall. *British Med. J.*, II, 10, July 1, 1933.

Colt and Lyall report a case of osteitis deformans treated with parathormone with apparent improvement. The chief involvement was in the cranium and femur where a pathological fracture occurred. Parathormone appeared to cause rapid healing of the fracture and relief from the symptoms due to pressure on cranial nerves.—*R. I. Harris, M.B., Toronto, Canada.*

**FRACTURES OF BOTH BONES OF THE LEG.** E. N. Wardle. *British Med. J.*, II, 146, July 22, 1933.

Wardle reviews the results obtained in forty-eight cases of fracture of the tibia and fibula treated by himself. His paper is a plea for manipulative reduction of these fractures rather than open reduction or skeletal traction. He believes that absolute anatomical restoration of the fragments is not necessary for good functional results. He strives to restore length and alignment and maintain good movement in the ankle and knee. His objections to open operation are that it delays union, and to skeletal traction that it invites infection and traumatizes joints.—*R. I. Harris, M.B., Toronto, Canada.*

**SPINAL CURVATURES—VISCERAL DISTURBANCES IN RELATION THERETO.** N. T. Ussher. *California and Western Med.*, XXXVIII, 423, 1933.

The author reviews the literature on the relationship between the afferent visceral and the efferent somatic sensations and concludes that there is a reverse process which causes visceral sensations resulting from irritation of the spinal nerves in the vicinity of the cord. He says, "This irritation may be due to a local myositis, osteo-arthritis . . . bony malformation at the nerve canals, or possibly direct pressure on these nerves due to the angle of curvature. In turn, because of the intimate relationship of the sympathetic network with that of the somatic nervous system, a motor reaction may occur in the innervated viscus," such as spasm, or a sensory reaction, as colicky pains or fullness. This may cause symptoms of gall-bladder disease, appendicitis, gastritis, colitis, etc. The author has found that active and especially young individuals are able to compensate for the spinal curvature, but, with the onset of fatigue and age, this diminishes and the "viscerospinal syndrome" appears. Five case histories are presented with symptoms of visceral disorders, apparent bronchial disturbances, and asthma, which have improved or disappeared upon partial correction of the spinal curvatures.—*Charles Lyle Hawk, M.D., Los Angeles, California.*

**ZUR BEHANDLUNG UND BEURTEILUNG DES WIRBELBRUCHES** (*Treatment and Evaluation of Cases with Fracture of the Spine*). Carlos Schleipen. *Deutsche Ztschr. f. Chir.*, CCXXXVIII, 618, 1933.

Immobilization as the main treatment in cases of fracture of the spine is generally used in the first period following the trauma. The kind of treatment for use in the second period, when consolidation of the fracture has occurred, has been much discussed. One

group of surgeons apply corset or brace to take the weight off from the fractured spine. Another group, especially Magnus, is strictly against immobilization. They believe that when the first painful symptoms have subsided, massage of the spinal musculature should start (third day after injury); after four weeks patients are allowed to sit up in bed and after six weeks to walk around; active exercises of the musculature are substituted for the corset.

The author reexamined the fracture cases of the surgical clinic in Freiburg where, during the last ten years, different kinds of treatment have been used. He had 280 cases at his disposal; 186 were fractures of the bodies (in fifty-four cases more than one body were broken); twenty-four were total or partial dislocations; four were fracture dislocations; sixty-three cases were fractures of the transverse processes. The author found that it is not advisable to let a patient with a healing fracture of the spine walk around because secondary changes and deformities are very likely to occur. Therefore, he uses crawling exercises, beginning with the seventh week after the fracture. The use of braces and corsets is to be rejected because it not only weakens the musculature and the ligamentous structures, but also because it extends the treatment and the patients return to work much later than when treated functionally. Out of 109 cases from which good history and follow-up data could be obtained, only ten were without trouble, observation time being two years. All the other patients had pain at the fracture site, especially with the change of weather, and were less able to work than before the injury. Only twenty-three of the patients could work in the same capacity as before.—*Ernst Freund, M.D., Iowa City, Iowa.*

SPÄTRESULTATE DER KNORPELRESEKTION BEI FISSURALER DEGENERATION DES KNEISCHNITTENKNORPELS (Late Results of Resection of the Cartilage in Cases of Fissural Degeneration of the Joint Cartilage of the Patella). K. H. Erb. *Deutsche Ztschr. f. Chir.*, CCXXXIX, 332, 1933.

The material of the Marburg Surgical Clinic from 1923–1927 was reexamined to prove Læwen's statement that by excision of the diseased cartilaginous area further development of an arthritis deformans can be delayed or even prevented. The author discusses briefly the etiology, diagnosis, and therapy. He believes that, despite all the symptoms mentioned in the literature, exact diagnosis can only be made after the knee joint is opened. Treatment should be surgical if long continued conservative measures are not followed by relief. Tourniquet is applied after blocking of the sciatic, femoral, obturator and the lateral femoral cutaneous nerves. Payr's S-shape incision is used. Motion is allowed very soon, at latest after one week. Eleven cases have been reexamined; seven patients answered questionnaires.

Altogether the results of resections of the degenerated patellar cartilage have been good. In no case have marked arthritic changes followed. Only small marginal exostoses at the patellar joint surface have formed in some cases. Besides the subjective feeling of improvement, the operation has prevented or delayed the further development of arthritic symptoms in four out of six cases which showed a deforming arthritis at the time of operation.—*Ernst Freund, M.D., Iowa City, Iowa.*

ANZEIGESTELLUNG ZUR BEHANDLUNGSART DER PSEUDARTHROSEN DER LANGEN RÖHRENKNOCHEN (Indications for Treatment of Pseudoarthroses of the Long Bones). Hans May. *Deutsche Ztschr. f. Chir.*, CCXXXIX, 184, 1933.

The author distinguishes four different groups of pseudoarthroses and each of them has its special treatment of choice:

1. All the bone-forming tissues are preserved, especially the periosteum. Because of a lack of hyperaemia, no callus is formed, or, if callus is formed, it remains in a low stage of development. Roentgenogram shows no atrophy, but no callus formation; fracture space is narrow. *Treatment:* all the non-surgical methods,—as mobilization and friction of fragments, drilling (Beck's), injection of blood (Bier's) or natrium glyccoll

phosphate. The purpose of these methods is to provoke hyperaemia and proliferation of bone-producing tissues.

2. All the bone-forming tissues are preserved and active. Pseudarthrosis has occurred because of unsurmountable obstacles. Roentgenogram shows good callus formation, but no or insufficient bridging. The fracture space is wide. *Treatment*: Excision of obstructing tissues, freshening of the fragments, and apposition.

3. Periosteum partially destroyed or scarred. Interposition of soft tissues. Roentgenogram shows fragments well preserved, little callus formation or joint formation (Bier). *Treatment*: Splitting of fragments, transplantation of spongy bone (Matti) from the trochanter region.

4. Complete destruction of periosteum and bone defects. No callus formation. Interposition of soft tissues, resorption of the fragments. Roentgenogram shows atrophy of fragments, no callus formation. *Treatment*: Autoplastic bone graft.

One hundred and forty-eight cases of pseudarthrosis have been treated in Lexer's clinic in Munich during the last ten years. Seventy-one cases were of pseudarthrosis of the long bones. Ten were treated by bloodless methods, nine surgically without bone transplantation; in fifty-one cases an autoplasmic bone graft was used; one case with double pseudarthrosis was fitted with a brace; and one case had an amputation because the skin over the pseudarthrosis was very bad. Out of the ten cases treated conservatively, in two, under an anaesthetic, the fragments were moved and rubbed. One was followed by bony union, the other had a bone graft later; there was interposition of the anterior tibial muscle. In two cases Beck's drilling was performed with good result. In three cases ossophyt was injected; in another three, callus extract; no result is given. Out of the nine cases treated surgically, but without bone graft, three were impacted; no result is given. In three cases the fragments were split after the operation; two showed bony union, one some motion. In three cases sequestra were found and removed; the bone ends were roughened. Good results.

Out of the fifty-one cases of pseudarthrosis treated with bone graft, forty cases were discharged as healed; six had a good result but were not completely solid. No follow-up. The other cases were failures.—*Ernst Freund, M.D., Iowa City, Iowa.*

#### BEOBSACHTUNGEN UND ERGEBNISSE BEI 400 MENISCUSOPERATIONEN (Observations and Results of 400 Operations on the Meniscus). Felix Mandl. *Deutsche Ztschr. f. Chir.*, CCXXXIX, 580, 1933.

In the light of recent literature, the author made an analysis of 400 cases of operation on the meniscus.

The medial meniscus is subject to injuries for other reasons than purely anatomical peculiarities. The lateral meniscus is clearly more prone to "snapping knee" and to cysts.

The large majority of meniscus injuries are due to trauma. Of the author's series, forty-eight were non-traumatic. Degenerative changes are the principal factors; the rupture is secondary in importance.

From the history, the histological characteristics, and the bilateral involvement, the author proposed, years ago, his conception of the non-traumatic origin of rupture of the meniscus. According to this view, which seems to be confirmed by further observations and by reports in the literature, the cartilages of the knee degenerate as a result of excessive burden imposed upon them; this leads to the changes which have been described. These changes facilitate the production of a complete rupture following trauma.

The diagnosis is to be made clinically. Roentgenography with contrast materials is not satisfactory. In twenty-one cases the diagnosis was erroneous; in eleven of these arthrotomy, as such, was absolutely indicated.

Recommendation is made for "relatively early operation". There are few contra-indications. The author warns against operation in compensation cases or personal injury cases involving damage suits.



For the operation local anaesthesia is used (subcutaneous and intramuscular infiltration with forty to fifty cubic centimeters of one-half per cent. novocain solution, and intraarticular injection of forty cubic centimeters of one per cent. novocain).

The after-treatment consists of mobilization and massage as early as possible. Prevention of joint effusion has not been successful.

In all cases requiring subsequent arthrotomy, regeneration of the cartilage was ascertained.

A follow-up examination was possible in 338 cases in which operation had been performed eight months to ten years previously. Of these 272 (80.5 per cent.) were cured,—free from symptoms, performing heavy labor, or taking part in athletics; 35 (10 per cent.) were laborers or athletes, but still had symptoms occasionally; 16 (4.7 per cent.) were able to work, but not to engage in athletics; 15 (4.5 per cent.) were unchanged. None of the patients had an aggravation of their condition and all showed a primary healing of their incisions.—*R. J. Dittrich, M.D., Fort Scott, Kansas*

**AN UNUSUAL DISEASE OF THE BONE MARROW (OSSEOMYELODYSPLASIA).** Clifford G. Grulee, Carl W. Apfelmach, and Ralph E. McMaster. *J. Am. Med. Assn.*, C, 162, 1933.

The author presents a new clinical syndrome that does not correspond to any known disease of the bone or bone marrow at this time. Myeloma, erythroblastoma, agranulocytosis, and several other diseases that produce similar clinical pictures were considered in the diagnosis, but were definitely ruled out by the observations and laboratory tests of the diagnostic study. He believes the disease to be a disturbance of the circulatory mechanism of the myeloid tissue.

The outstanding facts concerning this case are, briefly, a disease characterized by fever of an intermittent type, some joint symptoms, lack of much actual prostration, leukopenia, and a peculiar bone change throughout the course of the illness which was of a progressive nature. Successive roentgenograms showed a progressive thinning of the cortex of the bones and a corresponding increase in the size of the marrow cavity. In the vertebral column this thinning progressed to the stage where the vertebral bodies became so compressed as to cause cord pressure.

Autopsy on the patient showed grossly deformities of the vertebrae, ribs, and other bones which would occur from a softening of these bones and their consequent inability to oppose gravitational stresses and muscular tension. Section of the bones showed very thin cortex and markedly enlarged marrow spaces filled with a large, spongy, oedematous tissue. Microscopic examination of these bones showed the thinning of the cortex, the enlargement of the marrow, and within the marrow large, thin-walled, vascular spaces and multiple hemorrhages.—*H. E. Hipps, M.D., Dallas, Texas.*

**THE USE OF THE DRINKER RESPIRATOR IN THE AFTER-CARE OF INFANTILE PARALYSIS.** A. T. Legg. *J. Am. Med. Assn.*, C, 647, 1933.

The author calls attention to the fact that the mortality of infantile paralysis with involvement of the muscles has been brought down considerably by the use of the Drinker respirator, but that many of those who survive die a short time afterward with some lung disease, as a result of the diminished aeration, which they suffer. In many of these patients, following infantile paralysis with involvement of respiratory muscles and recovery, there results rather marked deformity in the thorax and chest, back, etc., due to paralysis, either bilateral or unilateral, of the chest and diaphragm.

The author uses the respirator as an exercisor for those patients who have so far recovered that they do not actually need it to preserve life. It prevents fatigue, however, in the muscles; produces chest expansion and breathing without muscular effort; prevents contractures in the paralyzed and strong muscles, so that chest deformity is prevented; increases aeration of the lungs and movement of the diaphragm and abdominal cavity;

and aids in the patient's general health. Considerable increase in the power of the paralyzed respiratory muscles has been noticed.—*Herbert E. Hipps, M.D., Dallas, Texas.*

**PELLEGRINI-STIEDA'S DISEASE.** A Report of One Case Surgically Treated. Jacob Kulowski. *J. Am. Med. Assn.*, C, 1014, 1933.

Pellegrini-Stieda's disease is characterized by semilunar-like bony formation in the region of the internal condyle of the femur and is always traumatic in origin. It has been described in foreign literature but this is the first case described in the English literature. The author gives a historical review of the condition with its onset and pathogenesis and reports a case on which he operated. In commenting upon this case he points out the similarity of this bony formation to myositis ossificans, and discusses the possibilities and probabilities of its origin.—*Herbert E. Hipps, M.D., Dallas, Texas.*

**FRACTURES OF THE HUMERUS.** Statistics and Treatment in Five Hundred Consecutive Cases. W. R. Cubbins and C. S. Scuderi. *J. Am. Med. Assn.*, C, 1576, 1933.

The authors present an exhaustive analysis of 500 consecutive cases with associated complications, types of treatments, and conclusions therefrom. The conclusions as presented by the authors are: Fractures of the upper two thirds of the humerus are most common in adults, while those of the lower third are more prominent in children. Open reduction was required in one out of every eighteen cases; non-union and delayed union occurred in one of every thirty-three cases. Radial paralysis, found in one of every thirty-four cases of fractured humerus and fractures of the surgical neck and shaft of the humerus, was best treated by primary immobilization of traction for from three to four weeks, secondary immobilization with Middledorp's triangle and airplane splint for an elbow bandage for two weeks, a period of total immobilization for from six to seven weeks.

They found that fractures of the greater tuberosity did not require ninety degrees of abduction except in rare cases. Supracondylar fractures gave the best results if treated in maximum flexion and complete supination. They note that foreign bodies should be avoided as much as possible in open reductions and point out the value of preserving the posterior periosteum in open reduction of fractures of the shaft of the humerus, as it more adequately preserves the osteogenic property of the fracture site and is a definite mechanical aid in immobilizing the fracture.—*H. E. Hipps, M.D., Dallas, Texas.*

**A BENIGN FORM OF OSTEOMYELITIS OF THE SPINE.** A. DeF. Smith. *J. Am. Med. Assn.*, CI, 335, 1933.

The author calls attention to the usual form of osteomyelitis of the spine with very acute symptoms, high fever, marked prostration, frequently paralysis from spinal cord involvement, and a high mortality. He notes, however, that there is a type of osteomyelitis of the spine which comes on rather insidiously and may present no more symptoms than a simple ache in the back and is often disregarded because no more definite clinical symptoms or findings can be elicited.

In the fourteen cases which the author presents, eleven had a diagnosis of tuberculosis of the spine; but suspicion that the lesion was not a tuberculous infection was aroused by the facts that they followed pyogenic infections in other parts of the body, there was a productive bone reaction about the lesion, and a tendency for early bony ankylosis of the body. Laboratory proved that many showed high leukocytosis, and cultures of staphylococcus aureus were obtained in several cases directly from the bone.

He notes that conservative treatment has given the best results, because of the tendency to early fusion and that, where fusion is done in a definitely osteomyelitic spine, sinuses often develop which hinder and retard the patient's recovery.—*P. M. Girard, M.D., Dallas, Texas.*

**SLIPPING OF THE EPIPHYSIS OF THE HEAD OF THE FEMUR. ITS RELATION TO RENAL RICKETS.** J. F. Brailsford. *Lancet*, I, 16, 1933.

The writer describes the x-ray appearance of the upper end of the femur in the pre-slipping stage of slipped upper femoral epiphysis. There is some increase in the density of the metaphyseal periphery of the epiphysis, some increase in the metaphysis, in part or throughout its whole breadth, with some wooliness of the outline of the extremity of the diaphysis. These features should be sought for in children suffering from discomfort or pain in the hip joint. The recognition of these features should lead to measures designed to prevent slipping.

The writer is of the opinion that disease, weight-bearing and strain, and trauma all play a part in the production of this condition. There is some disorganization of the metaphysis which lessens its capacity to withstand the normal sheering stresses and strains, and the condition may be brought into prominence sooner by some trauma which would not have affected the normal femur. Further, he believes that renal rickets may produce such a disorganization of the metaphysis. Several cases of slipped epiphysis are presented which showed albumin in the urine (no chemical findings of the blood are presented). The x-ray appearance of bones showing renal rickets is characteristic and also the changes may be seen in only one joint. This characteristic appearance is a thickening of the metaphyseal area. Consolidation and repair of the metaphyseal tissue in renal rickets may be seen, by roentgenographic examination, to take place in as short a time as one month. Renal rickets should be excluded before any operative procedures are undertaken on these cases. The urine should be examined for albumin on several occasions in these cases.—*Robert Perlman, M.D., Iowa City, Iowa.*

**SIGNS AND SYMPTOMS OF THE ACUTE STAGE OF ANTERIOR POLIOMYELITIS IN THE 1931-1932 EPIDEMIC.** S. F. McDonald. *Med. J. Australia*, I, 1, 1933.

In the "dromedary" type, the initial stage, lasting two to six days, strongly resembles dengue fever, but without neck or spine rigidity. Unless an abortive case, after a few hours to several days, temperature again rises, there develops spinal rigidity, and paralysis may or may not occur. In the first stage the spinal fluid cells are usually absent; at the beginning of the second stage there are a few polynuclears, and, with the localization of the disease, the lymphocytes and mononuclears increase.

Roughly, the cell count was proportional to the severity of the infection. Lumbar puncture was considered justifiable in any child with fever, headache, prostration, stiff neck and back. It was always done under general anaesthesia; but was not done where the child was desperately ill or after paralysis had set in.

Muscle tenderness came only after the onset of paralysis. The greatest susceptibility was in the age group from two to six years; but the older children tend to be more seriously crippled, bearing out the view that paralysis is more severe in the more hard-worked muscles.

The fatal cases occurred in those of the overwhelming toxæmic type, and in the ascending Landry type. The cell count was high in the Landry type, low in the toxæmic, encephalitic type.—*Edward N. Reed, M.D., Santa Monica, California.*

**A FEW NOTES ON THE SERUM TREATMENT OF ACUTE ANTERIOR POLIOMYELITIS.** Alec E. Paterson. *Med. J. Australia*, I, 5, 1933.

The advised dose was fifty cubic centimeters, twenty cubic centimeters to be given intrathecally and thirty cubic centimeters intravenously. The serum was given to seventy-four patients and the results were "beyond all expectation". The author feels that had more serum been available, larger doses would have been given and even better results obtained. As to method of administration, the patient was anaesthetized and the serum given, (a) at body temperature, very slowly, through the spinal puncture needle *in situ*, an additional five cubic centimeters of spinal fluid having first been withdrawn, (b) intravenously by cutting down and exposing a vein in the forearm.

The serum produced a profound general reaction, as a rule, which was considered beneficial. The reaction began in about four hours and lasted about twelve. It produced, first, great misery, then a sudden change to comfort. The spinal rigidity required about six days for disappearance. The author believes that spinal puncture and spinal therapy had no causative effect on spinal rigidity.

Contrary to the belief that, once paralysis has set in, serum is useless, the author thinks that no matter to what extent paralysis is present, so long as the patient is febrile, serum is beneficial.—*Edward N. Reed, M.D. Santa Monica, California.*

EPIDEMIOLOGY OF ANTERIOR POLIOMYELITIS, WITH SPECIAL REFERENCE TO THE QUEENSLAND EPIDEMIC, 1931-32. J. Grahame Drew. *Med. J. Australia*, I, 26, 1933.

The epidemic included 299 cases, 127 in the metropolitan area and 172 in the country. The morbidity rate was thirty-nine and seven-tenths per 100,000 in the city and twenty-eight and six tenths in the country. Mortality rate was fourteen and sixty-eight one-hundredths per cent. The average age incidence was from one to five years in the city, and from two to seven years outside the city. The possible causes of such an epidemic are discussed.

It has been demonstrated that during the incubation period the disease is infectious. The infection can probably be carried by objects which have been contacted by patients or by carriers.

The author believes that strict quarantine of patients and of all contacts should be instituted immediately when an epidemic commences, and that schools should be closed.

*Edward N. Reed, M.D., Santa Monica, California.*

A REPORT OF THE EPIDEMIC OF POLIOMYELITIS IN NEW SOUTH WALES, 1931-1932.

A. H. Tebbutt and Karen Helms. *Med. J. Australia*, I, 43, 1933.

The epidemic involved 435 cases. It began in the city of Sydney six weeks before it appeared in the country; about the same time-relationship between city and country as was observed in the New York epidemic of 1931. The mortality for Sydney was eleven and seven-tenths per cent., and for the whole state thirteen and one-tenth per cent.

After an exhaustive analysis, the author concluded that "a final statement cannot yet be made with regard to the rôle of convalescent serum therapy".—*Edward N. Reed, M.D., Santa Monica, California.*

THE RECENT EPIDEMIC OF POLIOMYELITIS FROM THE PHYSICIAN'S POINT OF VIEW.

Edgar H. M. Stephen. *Med. J. Australia*, I, 60, 1933.

Poliomyelitis can be recognized in its preparalytic stage. Reliance may be placed on the examination of the cerebrospinal fluid. The average incubation period is six to sixteen days. The onset is usually gradual but may be sudden, with paralysis appearing within twenty-four hours, sometimes without fever; or of the dromedary type, the paralysis following the second hump. The stages are that of systemic invasion with pyrexia and sore throat; that of meningeal involvement, with meningismus; and the paralytic stage.

The spine sign is probably present in nearly all cases but may be evident for a few hours only. Apprehensiveness was a striking feature. Twitchings and tremors, retention of urine, and lack of uniformity of deep reflexes are suggestive of the preparalytic stage. Sore throat was present in about one-fourth of the cases. As to neck and spine, there is apt to be unwillingness for manipulation and there may be muscular tenderness, some rigidity,—the spine sign. Head retraction is uncommon. The spine acts as a rigid column.

As to convalescent serum, the author believes:

1. That convalescent serum is of definite value.
2. That, when certain nerve cells have been threatened, the use of serum has prevented complete destruction.
3. That, when destruction has already occurred, serum is valueless.—*Edward N. Reed, M.D., Santa Monica, California.*

**ACUTE POLIOMYELITIS AS A PRIMARY DISEASE OF THE CENTRAL NERVOUS SYSTEM.**  
A Reconsideration of the Pathology, Symptomatology, and Treatment, Based on the Hypothesis of Axonal Propagation of the Infective Agent. H. K. Faber. *Medicine*, XII, 83, 1933.

This is a very excellent review of the whole question of acute poliomyelitis and, as the title infers, the subject has been treated exhaustively. Probably the most outstanding feature of this discussion is the author's hypothesis of axonal propagation of the virus in humans.

With regard to the portal of entry, the author states, "We may accept without much hesitation, the olfactory mucous membrane as the most probable route of penetration of the virus of poliomyelitis from the surface into the central nervous system".

Symptomatology is fully discussed under the heading of the four phases: (1) symptoms at the beginning, (2) symptoms subsequent to the onset but preceding the appearance of paralysis, (3) symptoms present at the onset of paralysis, and (4) period of recovery.

The discussion of "the route of propagation of the virus" leads up to the various phenomena seen in the course of the disease: (a) halting cases, (b) abortive cases, (c) dromedary cases, (d) cases with advancing paralysis, (e) subclinical poliomyelitis, and (f) relapses and second attacks. This is followed by a discussion of the "Conditions Favoring Recovery".

In treatment, the need for "supplying the maximum concentration of antibodies in the blood at the earliest possible moment, and maintaining this concentration as long as is necessary" is stressed. In this connection the author concludes, "Intravenous injection of whole blood or serum in large amounts from donors tested for immunity, appears to be the best method at present generally available. Foreign serum of high antibody titer, when this can be supplied, may be still better."

An excellent bibliography is appended.—*Clarence A. Ryan, M.D., Vancouver, British Columbia.*

**ROENTGENTHERAPY IN ARTHRITIS.** New Aspects and Technic. Heinz Langer. *Radiology*, XX, 78, 1933.

Of the two great types of chronic arthritis, the atrophic type shows at first an inflammatory reaction of the bones in the joint regions, with little osteoporosis; later, decalcification, disappearance of joint cartilage and, finally, complete ankylosis. There is leukocytosis and shortened sedimentation time. There is always effusion into the joint, at first.

The hypertrophic type shows deformity of the bony contours, with spur formation; but not decalcification. This type may show metabolic disturbance, endocrine imbalance, or repeated mechanical trauma. "The result of strain and stress of life appears in some persons in the form of arthritis."

The roentgen diagnosis of arthritis should always distinguish between atrophic and hypertrophic; though both may at times be present in the same patient. Various experiments in treatment of arthritis by x-ray have been abandoned because of severe reaction with increase of pain.

The author, as the result of animal experimentation, believes that x-ray produces on the vegetative nervous system first stimulation and later sedation.

He states that the generally accepted conception today is that arthritis is an anaphylactic reaction to a bacterial infection. The vegetative nervous system plays an important rôle in anaphylaxis.

The author treated with x-ray arthritic patients who showed marked symptoms of vegetative nerve disturbance, treating the region of the corresponding ganglia and nerves, and also the involved joints. Physiotherapy, internal medication, and removal of focal infection were carried out simultaneously. The results in the case in which x-ray treatment was added to the usual routine were convincing as to the value of radiation. The author feels that both the higher ganglia and the involved joints should be irradiated. The technique is given in detail. Both types of arthritis responded. Seventy-five per cent. showed increased pain, lasting generally for forty-eight hours; while in twenty-eight per cent. of these increased pain with general malaise lasted from one to two weeks. This reaction was followed by subsidence of symptoms and marked improvement in seventy-five per cent. of the cases treated, with slight improvement only in twenty-five per cent. Several courses of irradiation may be necessary.—*Edward N. Reed, M.D., Santa Monica, California.*

**DIAGNOSIS AND ROENTGENOLOGIC EVIDENCE IN SPONDYLOLISTHESIS.** Henry W. Myerding. *Radiology*, XX, 108, 1933.

Recognition of this deformity probably averages less than ten per cent., but has increased rapidly since 1920. In the author's series of 207 cases, 64 per cent. were hard-working people; the average age was forty years, and seventy-one per cent. were men. Nine per cent. of the cases were symptomless. When the result of trauma, the condition may be acute and very severe. The principle complaint is backache, aggravated by stooping and lifting and relieved by rest, with associated pain in legs, thighs, and hips in thirty-six per cent. There may be weakness and numbness. The patient may appear well and be gaining in weight.

Congenital anomalies of fifth lumbar and first sacral vertebrae are frequent. Trauma, added to such a congenital condition, often inaugurates pain and disability. Anteroposterior roentgenograms fail to show lesser degrees; lateral views are most important.

The author classifies the lesion as grade 1, 2, 3, or 4, according as the fifth lumbar slips forward less than one-quarter, one-half, three-quarters, or more than three-quarters of the distance across the lumbosacral joint. The angle of the lumbosacral joint varies from normal to perpendicular and the fifth lumbar may lie entirely displaced in front of the sacrum, with its articular surface facing the anterior border of the sacrum. Separation of the neural arch is often seen. The sacral promontory may be lipped, or sheared off. In fifty-four per cent. the fifth lumbar was smaller and flattened behind.

Two per cent. of the cases were "reverse spondylolisthesis",—a backward slipping of spinal column and torso. These caused no marked deformity. In eighty-six per cent. the slip was between the fifth lumbar and sacrum, in eleven per cent. between the fourth and fifth; and in one per cent. between the third and fourth.

Detailed reports and roentgenograms of eight cases are presented.—*Edward N. Reed, M.D., Santa Monica, California.*

**ATROPHIC AND HYPERTROPHIC ARTHRITIS OF THE SPINE.** A. R. Shands, Jr., and M. O. Oates. *Southern Med. J.*, XXVI, 384, 1933.

This is an analysis of cases seen at Duke University Hospital in the past two years. Excellent illustrations of types of arthritis of the spine are shown.—*F. G. Hodgson, M.D., Atlanta, Georgia.*

**ROGER ANDERSON APPARATUS IN FRACTURES OF THE LOWER EXTREMITY.** J. R. Bost. *Southern Med. J.*, XXVI, 507, 1933.

The author is very enthusiastic over the use of this apparatus, especially in fractures of the hip in elderly patients. Ten cases are reported.—*F. G. Hodgson, M.D., Atlanta, Georgia.*

AN OPERATION FOR LATE REDUCTION OF THE SEMILUNAR BONE. E. D. McBride. *Southern Med. J.*, XXVI, 672, Aug. 1933.

It is claimed that reduction gives better results than removal of this bone. The author stresses the importance of suturing the dorsal horn of the semilunar to the posterior edge of the radius. An incision, one and one-half inches long, is made on the dorsum immediately to the lunar side of the extensor carpi radialis. The fibrous tissue in the bed formerly occupied by the semilunar is carefully removed, a curved periosteal elevator is passed forward to free the anterior horn from the anterior surface of the radius, the bone is then pried back into position by a Davis skid. If it cannot be reduced without too much trauma, an additional anterior incision is made down to the bone. Complete reduction is recognized by the contour of the dorsal horn. It is difficult to bore a hole in the bone, so a crevice is made in the anterior face of the dorsal horn, creating a hook into which a strand of No. 00 plain catgut is inserted and sutured to the dorsum of the radius. The hand is put up in dorsal flexion in plaster splints.—*F. G. Hodgson, M.D., Atlanta, Georgia.*

ÜBER "RENALE RACHITIS" UND "RENALEN ZWERGWUCHS" (Renal Rickets and Renal Dwarfism). H. Hamperl und K. Wallis. *Virchows Arch. f. Path. Anat.*, CCLXXX-VIII, 119, 1933.

Report of two cases. Case 1, an eleven-year-old girl, proportionate dwarf (corresponding in size to a child six years and ten months old) died of chronic uraemia. Autopsy showed severe chronic interstitial nephritis of an unknown cause. Pathological changes in the bones were absent. Case 2, a girl, ten years and five months old, very small at birth, normal development until third year of life. Since the tenth year of life pain in the bones, difficulty in walking, dwarfism, size and proportion corresponding to a child of five and one-half years. Chronic nephritis with albuminuria. Roentgenograms show signs of a florid stage of late rickets. Autopsy showed interstitial chronic nephritis without inflammatory changes of the glomerulus and bone changes as in a severe florid stage of rickets.

A general discussion follows concerning the kidney and bone changes. It is possible that kidney lesions of a certain type lead to growth disturbance, dwarfism, with or without rachitic changes of the bones; but, contrary to common rickets, there is no hypophosphataemia, and usually there is hypocalcaemia. Specific antirachitic treatment seems to be without influence. On the basis of their two observations and of the study in the literature, the authors conclude that the metabolic disorder, provoked by the kidney lesion, may lead to the bone changes, but some unknown constitutional factor has to be present.—*Ernst Freund, M.D., Iowa City, Iowa.*

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